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Handmade Organic Mosquito Repellent (HOMeR)

The abandoned ricefields in our valley breed hordes of fierce mosquitoes, and at dusk they attack in force. But it's hard to tell which is worse, the mosquitoes or the commercial repellents.

Two weeks earlier we cut this lemon grass to the height of Midori's hand

The mosquitoes are horrific -- they're highly aggressive, you can be bitten hundreds of times without protection, it's torture, impossible to bear.

But the commercial repellant sprays mostly use diethyl-meta-toluamide (DEET), a nasty chemical that can cause rashes, swelling, eye irritation, and worse problems, though they're unusual -- including brain swelling in children, anaphylactic shock, low blood pressure, and one report of death. It hasn't had any of those effects on us (yet), but it's horrible stuff to have on your skin -- and with these mosquitoes you have to cover every single square inch of exposed skin. They'll even bite you right through a T-shirt or socks.

The alternative is incense coils, which you burn -- they fill the air with smoke containing insecticides. And indeed the mosquitoes keep away. We think this is very wise of them -- we don't like the coils any more than they do.

We tried all the herbal preparations, but they just don't work -- these mosquitoes are fierce!

So what to do? It's both an immediate problem and a longer-term one for us -- Journey to Forever will be travelling through many mosquito-infested and malarial areas.

We've found one good answer. We planted three stalks of **Thai lemon grass** (Cymbopogon citratus) we got from the local supermarket, and after a few months they'd grown into a composite clump about 15" across. We used a lot of stalks for cooking, but the clump didn't seem to get any smaller. We cut the tops every couple of weeks because it shaded out the other herbs in the herb bed (lots of green stuff for the compost), but it quickly grew back. And we found it keeps the mosquitoes away. It contains citronella oil, a safe and natural insect repellent that's just as effective as the commercial chemical

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products, especially when it's fresh. In fact lemon grass contains more than just citronella oil and is more effective than true citronella.

Rubbing the long, grassy leaves on the skin worked well, but the stalk worked even better. Take one stalk of fresh lemon grass (grip it near the ground and give it a sharp sideways tug to break it off from the clump), peel off the outer leaves, snap off the grass blades behind the swollen stem at the base. Bend the stem between your fingers, loosening it, then rub it vigorously between your palms so that it fractures into a kind of fibrous juicy mass, and rub this mess over all exposed skin, covering thoroughly at least once. Pleasant on the skin and effective: 98% protection at the Beach House at sundown, 100% any other time, and the effect lasts about 4-5 hours. In most places, where the mosquitoes are less fanatical, you can use less and it'll last longer.

We tried making tinctures so we could spray it, and this worked just as well.

To make HOMeR

- sustainable: made entirely from locally available renewable resources
- empowering: processed entirely by the end-user as needed
- eco-friendly: won't boil the planet or blow a hole in the sky.

Chop up the cores of five or six stalks of lemon grass and put them in a blender with a tumblerful of spirits, blend thoroughly. Can be further diluted by adding up to half as much water.

We used whatever booze we could find in the booze cupboard (we hardly drink at all, but people keep giving it to us), and strained it into a sprayer. The extremely cheap Chinese brandy went first, the Absolut Swedish vodka worked even better and we didn't smell quite as much like winos, and then we used London Dry Gin. When we get round to distilling fuel ethanol, we'll use that.

The only problem is that it goes stale after about a week and loses effectiveness -- does anyone know why, or how to prevent it going stale?

Can you find a better way? Young scientists in schools can really help us with this -- and it's not just for our sake (see below).

These are some of the kinds of preparations you can make with herbs:

- tinctures
- infusions
- decoctions
- fluid extracts
- essential oils

See below for further details.

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Handmade Projects
Ichijima
Japan

Magic herb

Lemon grass is also an effective herbal anti-fungal medicine (lemongrass tea) and in Puerto Rico people use the fibrous stalks as a natural toothbrush! Clean and tingling fresh! (Try it!)

This large clump of lemon grass grew from three small stems

According to the **CRC Ethnobotany Desk Reference** by Tim Johnson, lemon grass (Cymbopogon citratus) is traditionally used in various parts of the world as an antiseptic, antispasmodic, carminative, cyanogenetic, dentrifice, diaphoretic, diuretic, emmenagogue, expectorant, pectoral, preventative (cold), stimulant, sudorific, and tonic, used to treat common cold, consumption, cough, depurative, dyspepsia, elephantiasis, fever, flu, gingivitis, headache, hypertension, insecticide, leprosy, malaria, mouth sores, neuritis, pneumonia, pyorrhea, rheumatism, sprains, and toothache.

The Aromatic and Medicinal Plants Index at the **Purdue Guide to Medicinal and Aromatic Plants** has a lot of information on lemon grass, also listing it as an insect repellent and a medicinal plant, and says it's used in food and confections, in perfumes and cosmetics, soaps and creams, as a flavouring in soft drinks, and as a mask for industrial bad smells.
http://www.hort.purdue.edu/newcrop/med-aro/factsheets/LEMONGRASS.html

An altogether interesting plant -- like most plants, if not all of them. Other plant oils mosquitoes don't like are citronella, jojoba, neem, witch hazel, tea tree oil, peppermint, lemon basil, lemon oregano, lemon geranium, catnip, eucalyptus and pennyroyal.

Dr James A. Duke's **Phytochemical and Ethnobotanical Databases** lists lemon grass among 252 plants traditionally used as insecticides, 436 for malaria, 439 toothache, 58 for gum inflammation, 42 mouthwashes, 89 dentifrices, 15 for gum disease.
http://www.ars-grin.gov/duke/index.html

Three-quarters of modern medical drugs are plant-based. Most plant species haven't yet been studied for their potential medical benefits. Meanwhile thousands of plant species are lost forever each year because of deforestation and industrialized farming methods.

The mosquito menace

Deforestation and industrialized farming are also two of the factors causing an alarming increase in the range of mosquitoes.

The World Health Organization says global warming is also expanding the range of mosquitoes that carry malaria, yellow fever, and dengue fever, putting millions more humans at risk. Malaria mosquitoes are appearing in upland areas where they've never been seen before.

A child dies of malaria every 12 seconds, mostly in the Third World.

"In the history of the world, more people have died from diseases transmitted by mosquitoes than from all the fighting in all the wars," says appropriate technology company Jade Mountain.

"The world's most dangerous animal is the mosquito," according to a BBC World Service health program: malaria now infects approximately 110 million people annually, causing 2-3 million deaths, and with increasing drug resistance, the problem is worsening, while attempts to control the mosquitoes with pesticides have proved ineffective.

Malaria Poses Bigger Threat Than Previously Believed -- For more than 50 years, the mantra of "one million annual deaths due to malaria" has been cited by scientists and journalists. This estimate had gone unexamined in regard to its accuracy and economic implications. A new report, ""The Intolerable Burden of Malaria: A New Look at the Numbers", has found that at a minimum, between 700,000 and 2.7 million people die each year from malaria, more than 75 percent of them African children. Environment News Service, AmeriScan, August 2, 2001.
http://ens.lycos.com/ens/aug2001/2001L-08-02-09.html

The pesticides issue hit the headlines when an attempt to ban the use of the noxious and persistent insecticide DDT hit opposition from Third World countries which cannot afford the much more expensive alternatives.
http://ens.lycos.com/ens/sep99/1999L-09-07g.html

More about mosquitoes:
http://www.ag.usask.ca/cofa/departments/hort/hortinfo/pests/mosquito.html

Mosquito Information -- informative article by Tom Floore, American Mosquito Control Association, with illustrations: Mosquito Life Cycle, Mosquito Control, Mosquito-borne Diseases and more.
http://www.mosquito.org/mosquito.html

Alternatives

So, everywhere, the search is intensifying for safe, cheap, effective, locally available alternatives to pesticides and to the malaria drug treatments that no

longer work. In other words, plants.

Chinese scientists extracted an anti-malarial drug from the **Artemisia annua** fern, traditionally used against malaria for hundreds years. It is being used in Southeast Asia, Latin America and Africa and is proving effective against drug-resistant forms of malaria.

In India, a homemade mosquito repellent is proving particularly effective against the Anopheles mosquito which spreads malaria. It's made from low-cost neem oil from the amazing **neem tree** (Azadirachta indica, the "Village Pharmacy") mixed with coconut oil in concentrations of 1-2%.
http://www.theoriginalneemcompany.com/Misc/insectrepellent.asp
Neem is also proving effective against malaria itself, not just the mosquito that carries the parasite.
http://www.theoriginalneemcompany.com/usespages/page2/malaria.htm
One active component of the plant, gedunin, is said to be as effective as quinine on malaria-infected cell cultures.
http://www.theneemtree.com/medicinals4.htm
The Neem Tree - A Tree for Solving Global Problems
http://www.theneemtree.com/

Also in India, researchers have found that **peppermint** oil could be a new, cheap weapon in the fight against mosquito-borne diseases such as malaria, filariasis, dengue fever and West Nile virus. The oil not only repels adult mosquitoes but also kills the larvae. It was particularly effective against the Anopheles culicifacies mosquito, which is responsible for around three-quarters of malaria transmissions in the northern plains of India. -- BBC News, November 17, 1999
http://news.bbc.co.uk/hi/english/health/newsid_524000/524811.stm

Another promising candidate is catnip.

Catnip Repels Mosquitoes More Effectively Than DEET --
Researchers report that nepetalactone, the essential oil in catnip that gives the plant its characteristic odor, is about ten times more effective at repelling mosquitoes than DEET -- the compound used in most commercial insect repellents... A patent application for the use of catnip compounds as insect repellents was submitted last year by the Iowa State University Research Foundation. Funding for the research was from the Iowa Agriculture Experiment Station. -- American Chemical Society, 28 Aug 2001
http://www.sciencedaily.com/releases/2001/08/010828075659.htm

But: "I can't escape the idea that something is fundamentally wrong with these scientists. I learned about the mosquito repellant properties of catnip (Nepeta cataria) from my grandmother when I was a mere babe. Now these scientists have patented this century-old common folk knowledge." -- John, Organic Gardening Discussion List, 29 Aug 2001

What old folklore does YOUR grandmother know that might turn out to be more scientific than the scientists?

Biocontrol Network -- Biocontrol Reference Center, Products, Pest Guide, Discussion Board, FAQs -- Beneficial Insects and Organisms, Fly Control, Botanicals, Disease Control, Traps & Lures, Crawling Insect Control, Flying Insect Control, Bird Control, Creature Control, Soil Testing, Organic Fertilizers & Plant Foods, Composting, Seeds & Cover Crops, Lawn Care / Weed Control, Tools & Equipment, Pond and Septic Treatments, Home Care, Personal Care, Pet Supplies.
http://www.biconet.com/index.html

Forms of Medicinal Preparations

Infusions

These preparations are generally made of ground or bruised roots, barks, herbs, or seeds, by pouring boiling water over the drug, letting it stand for half-an-hour, occasionally stirring, and finally straining the clear liquid carefully off. Sometimes cold water may be used, as in the case of a few bitters, such as Calumba, Quassia, &c., when the ground drug will be found to yield its properties to water without heat. The usual quantity of drug to a pint of water is 1 ounce, but in a few cases where the drugs contain very active principles, less is sufficient. The dose of most infusions varies from a tablespoonful to a wineglassful or a teacupful.

Decoctions

As a rule decoctions are made by pouring cold water upon the cut, bruised, or ground drug, the mixture being boiled for twenty minutes to half-an-hour, cooled, and strained. Roots and Barks are generally treated in this manner, as they need longer subjection to heat to extract their virtues. Decoctions are generally made in a strength of 1 ounce to the pint, but, as the water boils away, it is best to use a pint and a half, and the decoction should then when finished measure 1 pint. The length of time depends upon the readiness with which the drug gives up its active principles to the liquid. The dose varies from two teaspoonfuls to a wineglassful or two.

Fluid Extracts

These are most popular and convenient preparations, inasmuch as they, if properly made, are the most concentrated fluid forms in which vegetable drugs may be obtained. Fluid extracts are made in a variety of ways -- evaporation by heat, in *vacuo*; cold percolation; high pressure, &c. -- each drug being treated in that manner by which its properties may be best extracted and held in concentrated solution. The strength of a Fluid Extract is 1 in 1, or 1 ounce fluid represents 1 ounce of crude drug -- for instance, 1 ounce of F1. Ext. Golden Seal would represent the medicinal value of 1 ounce of Golden Seal Root. Fluid Extracts are daily becoming more popular, and, as they may be easily

obtained, bid fair to rival the Tinctures and Preparations which have made Homoeopathy so popular with those who seek an easy way of keeping a household stock of domestic remedies.

Solid Extracts

Are prepared by evaporating to the consistence of honey the fresh juices or strong infusions of vegetable drugs. They may also be manufactured by a spirituous process, in which case the alcohol is recovered by means of distillation from a strong tincture of the drug. Solid extracts are employed chiefly in the manufacture of pills, plasters, ointments, and in more recent years also for compressed tablets.

Tinctures

Are spirituous preparations made with pure or diluted spirits of wine of drugs containing gummy, resinous, or volatile principles, or of any drugs rendered useless by the application of heat in any form, or of the great number of drugs which will not yield their properties to water alone, as their active principles are more readily extracted by spirit, better held in solution and preserved from deterioration.

Tinctures are generally made in a strength of 1 or 2 ounces of drug to the pint. The dose varies according to the active principles contained in the drug.

Concentrations

Are a class of medicinal resins or resinoids obtained from medicinal drugs by precipitation from their alcoholic preparations, either by water, distillation, or other suitable means.

Those at present in use contain one or more, but not always all the therapeutic virtues of the drugs from which they are made, and in many cases are only powdered extracts.

-- from **"Potter's Cyclopaedia of Botanical Drugs and Preparations"**, by R.C. Wren, F.L.S., Potter & Clarke, London, 2nd Edition, circa 1890.

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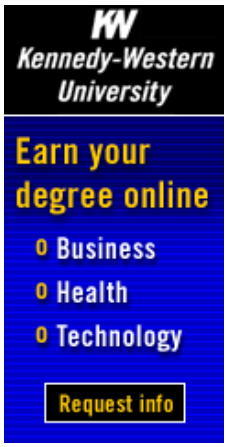

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http://www.acponline.org/journals/annals/01jun98/mosquito.htm

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Natural **Mosquito Repellents** [New Window]

You are here: About>Homework Help>Chemistry> Chemistry Databases> Chemistry Articles> Natural **Mosquito Repellents**. **...** Natural **Mosquito Repellents**. **...**

http://chemistry.about.com/cs/howthingswork/a/aa050503a.htm

3.

Mosquito Repellents [New Window]

... The effectiveness of a **repellent** depends on the **mosquito** species that is biting as well as the age, sex, level of activity, and attractivness of the human **...**

http://edis.ifas.ufl.edu/BODY_IN419

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http://journeytoforever.org/edu_homer.html

5.

Which **Mosquito Repellents** Work Best? [New Window]

... Botanicals (a eucalyptus-based **repellent** with no DEET); Lentek **Mosquito** Contro Plus, a wristband that emits sounds designed to ward off mosquitoes. The Results. **...**

http://magazines.ivillage.com/goodhousekeeping/consumer/out/articles/0,,284534_578827,00.html

6.

CDC: West Nile Virus - QA: Insect **Repellent** Use and Safety [New Window]

... outdoors. Q. When should I use **mosquito repellent**? A. Apply **...** mosquitoes. Q. What time of day should I wear **mosquito repellent**? A. Many **...**

http://www.cdc.gov/ncidod/dvbid/westnile/qa/insect_repellent.htm

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9.

KoreaTimes : Firms Oppose Ban on Camcera Cell Phones [New Window]

... to an end because hi-tech cell phones can help users **repel** mosquitoes. **...** The service, which costs 3,000 won per download, generates anti-**mosquito** sound waves to **...**

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We've found one good answer. We planted three stalks of **Thai lemon grass** (Cymbopogon citratus) we got from the local supermarket, and after a few months they'd grown into a composite clump about 15" across. We used a lot of stalks for cooking, but the clump didn't seem to get any smaller. We cut the tops every couple of weeks because it shaded out the other herbs in the herb bed (lots of green stuff for the compost), but it quickly grew back. And we found it keeps the mosquitoes away. It contains citronella oil, a safe and natural insect repellent that's just as effective as the commercial chemical products, especially when it's fresh. In fact lemon grass contains more than just citronella oil and is more effective than true citronella.

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Trees and forests
The Beach House fish pond
HOMeR
Eco-footprint
School and youth programs on the Web
Education resources on the Web
Children's poetry

Contact us

To Keith Addison
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Homepage
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Handmade Projects
Ichijima
Japan

stem between your fingers, loosening it, then rub it vigorously between your palms so that it fractures into a kind of fibrous juicy mass, and rub this mess over all exposed skin, covering thoroughly at least once. Pleasant on the skin and effective: 98% protection at the Beach House at sundown, 100% any other time, and the effect lasts about 4-5 hours. In most places, where the mosquitoes are less fanatical, you can use less and it'll last longer.

We tried making tinctures so we could spray it, and this worked just as well.

To make HOMeR

- sustainable: made entirely from locally available renewable resources
- empowering: processed entirely by the end-user as needed
- eco-friendly: won't boil the planet or blow a hole in the sky.

Chop up the cores of five or six stalks of lemon grass and put them in a blender with a tumblerful of spirits, blend thoroughly. Can be further diluted by adding up to half as much water.

We used whatever booze we could find in the booze cupboard (we hardly drink at all, but people keep giving it to us), and strained it into a sprayer. The extremely cheap Chinese brandy went first, the Absolut Swedish vodka worked even better and we didn't smell quite as much like winos, and then we used London Dry Gin. When we get round to distilling fuel ethanol, we'll use that.

The only problem is that it goes stale after about a week and loses effectiveness -- does anyone know why, or how to prevent it going stale?

Can you find a better way? Young scientists in schools can really help us with this -- and it's not just for our sake (see below).

These are some of the kinds of preparations you can make with herbs:

- tinctures
- infusions
- decoctions
- fluid extracts
- essential oils

See below for further details.

Magic herb

Lemon grass is also an effective herbal anti-fungal medicine (lemongrass tea) and in Puerto Rico people use the fibrous stalks as a natural toothbrush! Clean and tingling fresh! (Try it!)

According to the **CRC Ethnobotany Desk Reference** by Tim Johnson, lemon grass (Cymbopogon citratus) is traditionally used in various parts of the world as an antiseptic, antispasmodic, carminative, cyanogenetic, dentrifice,

diaphoretic, diuretic, emmenagogue, expectorant, pectoral, preventative (cold), stimulant, sudorific, and tonic, used to treat common cold, consumption, cough, depurative, dyspepsia, elephantiasis, fever, flu, gingivitis, headache, hypertension, insecticide, leprosy, malaria, mouth sores, neuritis, pneumonia, pyorrhea, rheumatism, sprains, and toothache.

This large clump of lemon grass grew from three small stems

The Aromatic and Medicinal Plants Index at the **Purdue Guide to Medicinal and Aromatic Plants** has a lot of information on lemon grass, also listing it as an insect repellent and a medicinal plant, and says it's used in food and confections, in perfumes and cosmetics, soaps and creams, as a flavouring in soft drinks, and as a mask for industrial bad smells.
http://www.hort.purdue.edu/newcrop/med-aro/factsheets/LEMONGRASS.html

An altogether interesting plant -- like most plants, if not all of them. Other plant oils mosquitoes don't like are citronella, jojoba, neem, witch hazel, tea tree oil, peppermint, lemon basil, lemon oregano, lemon geranium, catnip, eucalyptus and pennyroyal.

Dr James A. Duke's **Phytochemical and Ethnobotanical Databases** lists lemon grass among 252 plants traditionally used as insecticides, 436 for malaria, 439 toothache, 58 for gum inflammation, 42 mouthwashes, 89 dentifrices, 15 for gum disease.
http://www.ars-grin.gov/duke/index.html

Three-quarters of modern medical drugs are plant-based. Most plant species haven't yet been studied for their potential medical benefits. Meanwhile thousands of plant species are lost forever each year because of deforestation and industrialized farming methods.

The mosquito menace

Deforestation and industrialized farming are also two of the factors causing an alarming increase in the range of mosquitoes.

The World Health Organization says global warming is also expanding the range of mosquitoes that carry malaria, yellow fever, and dengue fever, putting millions more humans at risk. Malaria mosquitoes are appearing in upland areas where they've never been seen before.

A child dies of malaria every 12 seconds, mostly in the Third World.

"In the history of the world, more people have died from diseases transmitted by mosquitoes than from all the fighting in all the wars," says appropriate technology company Jade Mountain.

"The world's most dangerous animal is the mosquito," according to a BBC World Service health program: malaria now infects approximately 110 million

people annually, causing 2-3 million deaths, and with increasing drug resistance, the problem is worsening, while attempts to control the mosquitoes with pesticides have proved ineffective.

Malaria Poses Bigger Threat Than Previously Believed -- For more than 50 years, the mantra of "one million annual deaths due to malaria" has been cited by scientists and journalists. This estimate had gone unexamined in regard to its accuracy and economic implications. A new report, ""The Intolerable Burden of Malaria: A New Look at the Numbers", has found that at a minimum, between 700,000 and 2.7 million people die each year from malaria, more than 75 percent of them African children. Environment News Service, AmeriScan, August 2, 2001.
http://ens.lycos.com/ens/aug2001/2001L-08-02-09.html

The pesticides issue hit the headlines when an attempt to ban the use of the noxious and persistent insecticide DDT hit opposition from Third World countries which cannot afford the much more expensive alternatives.
http://ens.lycos.com/ens/sep99/1999L-09-07g.html

More about mosquitoes:
http://www.ag.usask.ca/cofa/departments/hort/hortinfo/pests/mosquito.html

Mosquito Information -- informative article by Tom Floore, American Mosquito Control Association, with illustrations: Mosquito Life Cycle, Mosquito Control, Mosquito-borne Diseases and more.
http://www.mosquito.org/mosquito.html

Alternatives

So, everywhere, the search is intensifying for safe, cheap, effective, locally available alternatives to pesticides and to the malaria drug treatments that no longer work. In other words, plants.

Chinese scientists extracted an anti-malarial drug from the **Artemisia annua** fern, traditionally used against malaria for hundreds years. It is being used in Southeast Asia, Latin America and Africa and is proving effective against drug-resistant forms of malaria.

In India, a homemade mosquito repellent is proving particularly effective against the Anopheles mosquito which spreads malaria. It's made from low-cost neem oil from the amazing **neem tree** (Azadirachta indica, the "Village Pharmacy") mixed with coconut oil in concentrations of 1-2%.
http://www.theoriginalneemcompany.com/Misc/insectrepellent.asp
Neem is also proving effective against malaria itself, not just the mosquito that carries the parasite.
http://www.theoriginalneemcompany.com/usespages/page2/malaria.htm
One active component of the plant, gedunin, is said to be as effective as

quinine on malaria-infected cell cultures.
http://www.theneemtree.com/medicinals4.htm
The Neem Tree - A Tree for Solving Global Problems
http://www.theneemtree.com/

Also in India, researchers have found that **peppermint** oil could be a new, cheap weapon in the fight against mosquito-borne diseases such as malaria, filariasis, dengue fever and West Nile virus. The oil not only repels adult mosquitoes but also kills the larvae. It was particularly effective against the Anopheles culicifacies mosquito, which is responsible for around three-quarters of malaria transmissions in the northern plains of India. -- BBC News, November 17, 1999
http://news.bbc.co.uk/hi/english/health/newsid_524000/524811.stm

Another promising candidate is catnip.

Catnip Repels Mosquitoes More Effectively Than DEET -- Researchers report that nepetalactone, the essential oil in catnip that gives the plant its characteristic odor, is about ten times more effective at repelling mosquitoes than DEET -- the compound used in most commercial insect repellents... A patent application for the use of catnip compounds as insect repellents was submitted last year by the Iowa State University Research Foundation. Funding for the research was from the Iowa Agriculture Experiment Station. -- American Chemical Society, 28 Aug 2001
http://www.sciencedaily.com/releases/2001/08/010828075659.htm

But: "I can't escape the idea that something is fundamentally wrong with these scientists. I learned about the mosquito repellant properties of catnip (Nepeta cataria) from my grandmother when I was a mere babe. Now these scientists have patented this century-old common folk knowledge." -- John, Organic Gardening Discussion List, 29 Aug 2001

What old folklore does YOUR grandmother know that might turn out to be more scientific than the scientists?

Biocontrol Network -- Biocontrol Reference Center, Products, Pest Guide, Discussion Board, FAQs -- Beneficial Insects and Organisms, Fly Control, Botanicals, Disease Control, Traps & Lures, Crawling Insect Control, Flying Insect Control, Bird Control, Creature Control, Soil Testing, Organic Fertilizers & Plant Foods, Composting, Seeds & Cover Crops, Lawn Care / Weed Control, Tools & Equipment, Pond and Septic Treatments, Home Care, Personal Care, Pet Supplies.
http://www.biconet.com/index.html

Forms of Medicinal Preparations

Infusions

These preparations are generally made of ground or bruised roots, barks, herbs, or seeds, by pouring boiling water over the drug, letting it stand for half-an-hour, occasionally stirring, and finally straining the clear liquid

carefully off. Sometimes cold water may be used, as in the case of a few bitters, such as Calumba, Quassia, &c., when the ground drug will be found to yield its properties to water without heat. The usual quantity of drug to a pint of water is 1 ounce, but in a few cases where the drugs contain very active principles, less is sufficient. The dose of most infusions varies from a tablespoonful to a wineglassful or a teacupful.

Decoctions

As a rule decoctions are made by pouring cold water upon the cut, bruised, or ground drug, the mixture being boiled for twenty minutes to half-an-hour, cooled, and strained. Roots and Barks are generally treated in this manner, as they need longer subjection to heat to extract their virtues. Decoctions are generally made in a strength of 1 ounce to the pint, but, as the water boils away, it is best to use a pint and a half, and the decoction should then when finished measure 1 pint. The length of time depends upon the readiness with which the drug gives up its active principles to the liquid. The dose varies from two teaspoonfuls to a wineglassful or two.

Fluid Extracts

These are most popular and convenient preparations, inasmuch as they, if properly made, are the most concentrated fluid forms in which vegetable drugs may be obtained. Fluid extracts are made in a variety of ways -- evaporation by heat, in *vacuo*; cold percolation; high pressure, &c. -- each drug being treated in that manner by which its properties may be best extracted and held in concentrated solution. The strength of a Fluid Extract is 1 in 1, or 1 ounce fluid represents 1 ounce of crude drug -- for instance, 1 ounce of F1. Ext. Golden Seal would represent the medicinal value of 1 ounce of Golden Seal Root. Fluid Extracts are daily becoming more popular, and, as they may be easily obtained, bid fair to rival the Tinctures and Preparations which have made Homoeopathy so popular with those who seek an easy way of keeping a household stock of domestic remedies.

Solid Extracts

Are prepared by evaporating to the consistence of honey the fresh juices or strong infusions of vegetable drugs. They may also be manufactured by a spirituous process, in which case the alcohol is recovered by means of distillation from a strong tincture of the drug. Solid extracts are employed chiefly in the manufacture of pills, plasters, ointments, and in more recent years also for compressed tablets.

Tinctures

Are spirituous preparations made with pure or diluted spirits of wine of drugs containing gummy, resinous, or volatile principles, or of any drugs rendered useless by the application of heat in any form, or of the great number of drugs which will not yield their properties to water alone, as their active principles are more readily extracted by spirit, better held in solution and preserved from deterioration.

Tinctures are generally made in a strength of 1 or 2 ounces of drug to the pint.

The dose varies according to the active principles contained in the drug.

Concentrations

Are a class of medicinal resins or resinoids obtained from medicinal drugs by precipitation from their alcoholic preparations, either by water, distillation, or other suitable means.

Those at present in use contain one or more, but not always all the therapeutic virtues of the drugs from which they are made, and in many cases are only powdered extracts.

-- from **"Potter's Cyclopaedia of Botanical Drugs and Preparations"**, by R.C. Wren, F.L.S., Potter & Clarke, London, 2nd Edition, circa 1890.

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Support Journey to Forever

If you find our website useful, if you think our project is worthwhile, you can help us to make it matter with a donation.

There are only two of us (so far!) and we don't have any commercial sponsorship or financial support -- Journey to Forever is all our own work.

Our true destination is an END to the poverty and hardship that afflict billions of people in this world of plenty. We know we'll never get that far, but your donation will bring us a little closer.

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Midori Hiraga, a/c2031000348
California Account Customer Support Unit,
Union Bank of California,
PO Box 2306, Brea, California 92822-2306, USA

Print this address.
Please notify us.

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4. Kagi
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Journey to Forever

Hong Kong to Cape Town Overland

Japanese | Chinese

AN INTERACTIVE ADVENTURE –

- the first-ever overland expedition from East Asia to Southern Africa
- the first to use the Internet to link schools and communities all along the route
- the first to offer schoolchildren everywhere an active role in confronting the environmental issues threatening the future of our planet

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Our website has had more than 8 million visits!

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The Project

Journey to Forever is a pioneering expedition by a small, mobile NGO (Non-Government Organization) involved in environment and rural development work, starting from Hong Kong and travelling 40,000 kilometres through 26 countries in Asia and Africa to Cape Town, South Africa.

Our route will take us away from the cities and populated districts to remote and inaccessible areas (usually also the least developed and poorest areas), where we'll be studying and reporting on environmental conditions and working for local NGOs on rural development projects in local communities.

The focus will be on trees, soil and water, sustainable farming, sustainable technology, and family nutrition.

The aim is to help people fight poverty and hunger, and to help sustain the environment we all must share.

Seats for everyone

This is a participatory project. It's both a real journey and a virtual one via a high-speed satellite link with the vehicles and interactive forums online at our Website, where participants -- expert consultants or anyone with a PC and a modem, and especially schoolchildren -- can take an active part in the project as it

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unfolds.

Participation will be real, not just a token: the project team will organize the expedition, undertake the journey and do the work, but we'll be looking to our online participants to help give the project its shape as the journey unfolds.

Whoever you are and wherever you are, you can make a real difference! Everybody's welcome -- it's free, and open to all.

Schools

Schoolchildren are a special part of Journey to Forever -- this is a wonderful opportunity for students to learn about the issues that are so vital to the world they'll inherit.

At the same time they'll learn how to use the new information technology in innovative and creative ways, linking and collaborating with other children in other lands, learning together, and contributing to real issues.

It's open to schools everywhere -- via satellite link, we'll take participating schoolchildren into classrooms in villages very far from anywhere.

Good news

Environment and development issues are usually bad news: millions of children starve, tropical forests are destroyed, pollution spreads everywhere, there's even a hole in the sky.

But that's only one side of the story. Journey to Forever will cross a huge expanse of the globe, and we expect to find plenty of good news and cause for optimism -- and to help demonstrate that ordinary people, even children, can make a positive contribution to the health and future of this most beautiful planet.

First stop

Japan! -- not indeed a poor Third World country. Our stay here is the final part of project preparation before starting the journey.

We're living in a 100-year-old traditional farmhouse in a rural village up in the mountains near Kyoto, with farming land and workshops, we're much involved in on-the-ground sustainability,

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Biodiesel with Journey to Forever -- in Spanish
EN ESPAÑOL, sitio hermano para biodieseleros DIY

What people are saying about us

StudyWeb Academic Excellence Award -- "selected as a featured site in Lightspan's StudyWeb as

Appropriate Technology and biofuels projects here and elsewhere in Japan. We're giving all our technology and resources a final, real-world test-run, finding and filling in the gaps, adapting what needs adapting, developing what's missing. When we're ready, we'll leave, and the Journey-proper will begin.

More news soon!

FYI

News that's not in the news

IMF and World Bank: Out of Control -- THE International Monetary Fund and World Bank are institutions out of control. For evidence, consider the institutions' feeble and fatally flawed debt relief program. Under their Highly Indebted Poor Country (HIPC) initiative, the world's poorest countries can receive reduction of approximately one third of their current payments to overseas creditors -- if they endure six years of closely monitored, extremely intrusive "structural adjustment." ... HIPC is the institutions' most important fig-leaf, a program designed to obscure the view of the harm they are doing to poor countries.

Greenwash + 10 -- The UN's "Global Compact" with global corporations associates with notorious violators of UN values -- Global Compact companies have already violated the Principles of the Compact, without censure -- or even acknowledgement -- from UN officials. The Global Compact represents a smuggling of a business agenda into the United Nations. It should not be considered a contribution to or framework for the Johannesburg Summit. Here's the evidence.

one of the best educational resources on the Web", 11 April 2001

EDITOR'S CHOICE AWARD
Awesome Library: top 5% of K-12 education sites

Listed at **Education World** -- "Where educators go to learn"

Technology and the poor -- The United Nations Development Programme's "Human Development Report 2001 -- Making new technologies work for human development" attempts to address a key question for the 21st century: will technology entrench millions in even greater poverty -- or can it be used to eradicate poverty and suffering? But the key issue is not "making new technologies work for human development" but enabling poor people to make technologies work for them.

Philip Morris Sees the Light -- After decades of denial about the hazards of tobacco, Philip Morris has been promoting the benefits to society of premature deaths from smoking, in a study that found the early deaths of smokers have "positive effects" for society that more than counteract the medical costs of treating smoking induced cancer and other diseases.

The Enemies of Democracy -- Report of a chilling, documented history of ongoing corporate efforts to use propaganda and "public relations" to distort science, manipulate public opinion, discredit democracy, and consolidate political power in the hands of a wealthy few.

Murder that is a threat to survival -- When indigenous peoples lose their languages, unique ecological knowledge also disappears. Languages are being murdered faster than ever before.

Seed patents threaten world food resources -- The threat to the future availability of the seeds used to feed the world.

The wreckers who trade in misery -- There is a real danger that dedicated and well-organised groups will cause the rules-based trading system to collapse, destroying efforts to reduce poverty and global inequality.

BP -- Beyond Preposterous -- BP spent more on its new eco-friendly logo in 1999 than on renewable energy. BP's second Greenwash award in 18 months.

Shell wins Greenwash Award -- Shell claims it is at the forefront of reducing harmful greenhouse gases, but the company is full of hot air.

Talking pure manure -- Agribusiness mouth Denis T. Avery is a liar, and he knows it. Here's the proof., and the truth of the matter.

Hi-tech crops are bad for the brain -- "Miracle" crops, hailed as the answer to global famine, are contributing to widespread brain impairment in the developing world, a new report concludes.

The WTO: "These guys just don't get it!" -- "This was supposed to be a seminar on how to rebuild public confidence in the WTO, not transform the agency into the former Soviet KBG."

Countering myth with facts -- "Agriculture [read: "agribusiness"] needs to educate the general public and government officials to counter myth with facts". But which is which?

Rape of a rainforest -- Malaysian timber companies have become notorious for their systematic destruction of the world's remaining rainforests: report on an ecological and social crime.

Do pesticides cause cancer? -- The answer, from chemical corporation Monsanto's "Fact Sheet On Pesticide Use": "Number of active ingredients in pesticides found to cause cancer in animals or humans: 107." Read on!

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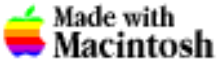
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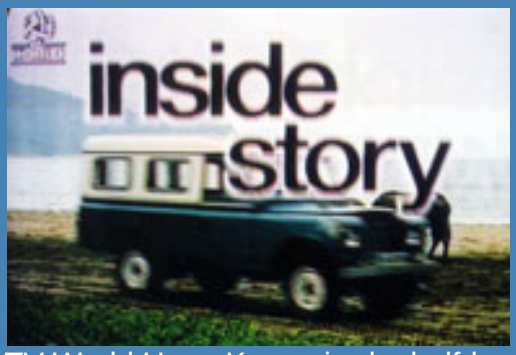
Ming Pao Daily, Hong Kong, 14 April 1999



ATV World Hong Kong aired a half-hour prime-time documentary on Journey to Forever on "Inside Story"on 21 June 1999 (re-broadcast on 27 December 1999)

South China Morning Post Sunday Magazine, 21 November 1999

Media publicity

- South China Morning Post Sunday Magazine, Hong Kong, feature story, 21 November 1999
- The Japan Times, 11 August 1999
- Mainichi Daily News, Japan, 11 August 1999
- South China Morning Post, Hong Kong, lead letter, 20 July 1999
- Hong Kong Economic Times, 5 July 1999
- ATV World, Hong Kong, Inside Story, half-hour prime-time documentary, 21 June 1999;
  -- re-broadcast on 27 December, 1999
- Radio 3, RTHK, Hong Kong, interview, 1 May 1999
- Ming Pao newspaper, Hong Kong, News Focus, 30 April 1999
- Ming Pao newspaper, Hong Kong, lead article, main feature page, 14 April 1999
- Rotary Club of Hong Kong Island West, guest speaker, 9 April 1999

See **Biodiesel in Hong Kong** for more press publicity.

Ming Pao Daily, Hong Kong, 30 April 1999

Midori as guest speaker at the Rotary Club of Hong Kong Island West, 9 April 1999

Hong Kong Economic Times
July 5, 1999
20輛小巴 10月試用生化柴油
商會與環保機構合作 原料來自食肆

HK Economic Times, 5 July 1999

South China Morning Post
COMMENT
LETTERS TO THE EDITOR
Don't allow biodiesel opportunity to slip away

South China Morning Post, Hong Kong, 20 July 1999

Awards and recommendations

EDITOR'S CHOICE AWARD
Awesome Library: a collection of the top 5% of sites in the field of K-12 education

Top 5% in K-12 Education

Listed at **Education World**

"Where educators go to learn"

StudyWeb Academic Excellence Award

"Selected as a featured site in Lightspan's StudyWeb as one of the best educational resources on the Web", 11 April 2001

What people are saying about us

"I am REALLY impressed! This is seriously the best web site on these subjects I have ever seen, made all the better because it was put together by somebody who's actually DOING these things and not just reading about them! What a wonderful thing you are doing, Keith... that really made my day to see it. I thought I'd put in a plug for your site on the list, too, especially for those who are homeschooling. Your site is a kid's every dream come true."
-- *Lee Flier, Permaculturist, Third World development*

The Japan Times

H.K.-Cape Town drive a quest for answers to world's survival

The Japan Times, 11 August 1999

The International Newspaper of Japan

MAINICHI Daily News

Wednesday, August 11, 1999

MAINICHI DAILY NEWS

DOMESTIC

Woman starts HK-Cape Town odyssey

Mainichi Daily News, Japan, 11 August 1999

worker, host of the Homestead mailing list

"Excellent site. Top notch. Skeptics should check out Poultry for small farms. This is the best overview of the subject that I have seen. I will send to the gardening site all those who complain that they don't have enough room to garden. And I especially appreciate the pertinent news reporting with sources attached."
-- Gene GeRue, author of "How To Find Your Ideal Country Home"
http://www.ruralize.com/

"Your website has occupied my attention all day now. Your Journey is very intriguing... I agree with you that 'change is in the air' and I think many people are tired of feeling cynical and hopeless, and are 'hungry' for new leadership and wisdom to, as you say, 'mix the old with the new' and 'fix what we have broken'."
-- Cheryl Long, Senior Editor, "Organic Gardening Magazine"

"Congratulations on your inspiring web site and your phenomenal project! I was fighting back tears as I read over your web site today. Your vision is so powerful that you will have many followers on your journey."
-- Joshua Tickell, Writer -- Photographer
http://www.veggievan.org/

"Try driving from Hong Kong to South Africa while doing development work along the way and you end up driving, well, almost forever. Journey to Forever is awesome and it is the primary inspiration for eVoyage."
-- Joshua Tickell, eVoyage
http://eVoyage.org/

"Hands down, my pick of the season is Journey to Forever"
-- Spring edition of The Biodiesel Newsletter (6,000 subscribers in 20 countries).
http://www.veggievan.org/

"You have expanded my horizon and the notebook, great start to the day."
-- Heidi Carter, preparing a resource notebook for the 1890 Land-Grant Universities Agroforestry Conference from June 13 to 15, 2000, at Alabama A & M University.

"I very much enjoyed reading your material, and I want to thank you for the trouble you went to to make it available."
-- *Bill Hunt*

"I had to let you know that we had some wonderful success based on information we obtained from your web site. Keep up the good work..."
-- *Dave Margetts, making biodiesel in Ontario, Canada*

"It really was a journey to forever
And I for one enjoyed the journey and
I will come back again
For you have made it plain
Re-cycling is what can save our land

"Each of us can do a little something
And your site will inspire and hopefully
Lead others down the path that we are both on
Into a happier world most definitely

"Keep up the good work"

-- *Rex Tyler, Cook's Delight, organic grocer and online shop, Berkhamsted, Hertfordshire, UK*
http://www.organiccooksdelight.co.uk/

"Thanks -- you guys are doing a great thing and I want to help to spread the consciousness of alternative energy possibilities."
-- *Josh Thayer*

"Great job -- keep up the great work."
-- *Sal, "Don't Panic -- Eat Organic" -- an organic farmers homepage*
http://www.rain.org/~sals/my.html

"I'm so overwhelmed! I could spend weeks at this site!"
-- *Kay Dixon*

"I could spend hours reading it! I've bookmarked it for the kids, too!"
-- *Tammy in Colorado*

"Thanks and praises for an excellent site -- a nexus, or a vortex, where all the basics are covered ... brilliant!"

-- earth sol

"I can only be astonished by you and Keith's dream, direction, and warmness for the people all over the world. I hope I can learn through this journey and help people who are indeed in need of support and care."
-- *William, student, Hong Kong*

"You are great! I want to know more about your trip. It is a great job. I am a teacher, can our students join the project, such as join the discussion or share the experience?"
-- *Chris, teacher, Hong Kong*

"I'm not sure why, but I shed tears after reading about your planned journey. I think it is a terribly meaningful thing to do. Please let me know the details of your trip as it progresses. I hope I can be of help in whatever small way."
-- *Simon, Hong Kong*

"The trip is really very interesting and meaningful. I really want to join the journey!"
-- *Virginia, student, Hong Kong*

"Journey to Forever is very interesting and meaningful. Especially in Hong Kong, it is rare for people to devote something to the environment and poverty. I deeply appreciate your efforts."
-- *Rex, student, Hong Kong*

"You should know that I am proud that I have friends like you who are going on such a fulfilling, meaningful and challenging journey."
-- *Anna, journalist, Hong Kong*

"I really want to join your journey, but I just don't know if it is possible. I am ready to postpone my degree if I can go... the achievement of my long-term dream and my studies, I choose the former."
-- *Billy, student, Hong Kong*

"You're doing a great thing."
-- *Susan, journalist, Hong Kong*

"I salute your dedication and devotion for the world and environment."

-- Damar, manager, Hong Kong

"Most of the teachers think this is a worthwhile project. It helps us teach our kids about things outside the classroom and outside Hong Kong, and it also involves environmental protection which is so important nowadays.

"At the same time it helps us let our kids make use of Information Technology, not only in the classroom but even communicating with people at any spot anywhere in the world. I think that will be a very meaningful task in education.

"Most of our kids grew up in a modern city, some of them haven't even seen a live cow. This is a chance for us to open our kids to nature."
-- Au Pak Kuen, Vice-president, Hong Kong Professional Teachers' Union (from Inside Story documentary on Journey to Forever, ATV World, 21 June 1999)

"The most effective way of all to teach kids about what life is like in developing countries is to take them there. That of course is only possible for very small numbers. We've done that before and it was quite remarkable, it really was a life-changing experience.

"If Journey to Forever can somehow bring to life on the Web and make as real as possible what they are seeing as they go on their journey, then that's the next best thing to kids actually being able to go there and see for themselves."
-- John Sayer, Director, Oxfam Hong Kong (from Inside Story documentary on Journey to Forever, ATV World, 21 June 1999)

Community development | Rural development
City farms | Organic gardening | Composting | Small farms | Biofuel | Solar box cookers
Trees, soil and water | Seeds of the world | Appropriate technology | Project vehicles

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About Handmade Projects

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The team

Keith Addison and Midori Hiraga founded Handmade Projects NGO in Hong Kong in 1998 to organize the Journey to Forever project, moved into the old Beach House canteen in Pui O village on Lantau Island and made it the project headquarters.

The Beach House: where Journey to Forever was planned

The project was conceived in 1997 when Keith revisited Cape Town, his birthplace.

"I left South Africa 25 years ago, for political reasons," he says. "I worked for the black press there, until 1976, the year of the Soweto Uprising. It was led by schoolkids. All over the country black schoolkids went on strike and took to the streets in protest at the apartheid system.

"The response was vicious -- the police shot at least 2,000 black schoolchildren that year. It wasn't really a surprise, I'd seen it coming, but it was a hell of a shock just the same. And it didn't leave any hope for peace -- you can't expect people to be reasonable after you shoot their children in the streets. So I left, and came here to Hong Kong. I've spent most of my time around here and in Europe since then.

"I more or less forgot about South Africa and got involved in Third World development work instead.

Actually there wasn't that much difference, black people in South Africa shared a great deal with Third World people: rural poverty, the victims of an unjust system.

"I went back a couple of times, briefly, for family reasons, but I wasn't at all pleased to be there and couldn't leave soon enough.

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Keith harvesting sweet potatoes at the Beach House on Lantau Island

But in the early 90s things started to change in South Africa. Nelson Mandela was freed, and a lot of my friends returned after that. I couldn't see it though -- millions of lives ruined, a long and terrible heritage of brutality and oppression... It would take more than letting one man out of jail to fix that.

Unloading water buffalo manure from the Land Rover -- good compost material

"Yet, it made all the difference. The kind of power that grows from the barrel of a gun is useless against a man like Nelson Mandela. It was really the schoolkids who started it in 1976, but in the end the armed might of the apartheid regime was defeated by the sheer moral force of one man's spirit, and that's about the best thing of I've ever heard of, it makes everything seem possible.

"Anyway, in 1997 there was a bit of a family crisis once again, which I could have shrugged off, but I decided to go and see how I felt about the place these days. And I was glad I did: I got a very good feeling about it. Sure, it's still got every kind of problem, but they don't shoot children in the streets anymore. What we'd been working for and hoping for back in those old days was coming to pass: there was hope again, where there'd been none.

"So I decided to go back. I wasn't sure it was actually 'back', and it definitely wasn't back 'home' -- I long ago lost the concept of home, I don't even feel the need for such a thing now, nor any sense of loss either. But it felt like I should go there and see what would happen to me. I know feelings like that, they've been leading me around by the nose all my life, no sense in arguing, you just have to do it.

"Then I went back to Hong Kong. And found myself thinking, Yes, that's all very well, but what about my Land Rover? I really liked my Land Rover -- it hadn't been running for more than a

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http://journeytoforever.org/

Handmade Projects
Ichijima
Japan

year and had been sidelined by silly bureaucratic problems and bits of paper and so on, but I wasn't prepared to abandon it. I'd had lots of adventures in Land Rovers but I'd never owned one before, it was a real thrill. Also it's kind of special -- Land Rover Lightweights are not easy to come by.

"So I found out how much it was going to cost me to put it in a container to go by sea, and I'd go by air, but then I thought, No, that can't be right, it's supposed to take me, not me take it.

Keith driving the Land Rover Lightweight at Pui O beach (Dan Groshong)

"So that's how Journey to Forever came about -- it's the Land Rover's crazy idea, not mine. It wants to go for a ride.

"It was never going to be just a journey, from A to B. I've done a lot of travelling journalism, I can easily earn a living that way. So that's what I'd do, a long -- really long! -- working trip, chasing stories all along the way, spending a lot of time off the beaten track, and the Land Rover would take me anywhere I wanted to go, perfect.

"And with a laptop and a satellite communications unit I'd be really independent, full Internet access from anywhere. This is what I'd always wanted to do.

"Then I started to realize that the Land Rover's capable of a lot more: they're built for rural work, you can run all kinds of machines and implements off them -- powerful things to take into poor Third World villages. And my own capabilities -- I'm a Third World journalist, but I haven't just written about Third World projects, I've done them.

"So the journey turned into a sort of moving development project. As well as researching and delivering stories, I could also use the Internet to access expert advice when we needed it. With all this in mind, the opportunities for education seemed obvious, so it became a schools project too.

"Good, now we had a proper project plan -- 'we' since Midori had joined the project by then. But that's her story, not mine.

Midori and a one-basket garden, for schools projects

"Why 'Journey to Forever'? Well, look around: the way we humans are behaving these days you'd think you can buy new planets by the dozen in the local supermarket. The deserts are spreading, the forests are shrinking, the climate is changing, the water's drying up, whole species vanish for good by the minute, pollution is literally everywhere, there's even a hole in the sky, and never before have so many people been so poor and so few people been so rich.

"This is not what people want, but most people feel helpless to do anything about it. Some people now see humans as some kind of super-predator that's gotten right out of control, a sort of planetary cancer, and the sooner we destroy ourselves, well, the better for everything else.

"But it's just not true. In fact most people live pretty much in harmony with nature, as they've always done -- all the traditional ways of life around the globe got that right a long time ago, or they'd never have survived this far. But it's getting difficult to follow the old ways -- impossible, for many.

"Why? Overpopulation? It's a myth, a symptom of what's wrong, not the cause of it. Nearly a billion go hungry -- in a world where never before has there been so much food per capita: 4.3 lbs of food per day for each human alive, more than enough for everyone.

"Hundreds of millions are landless -- while in some of the hungriest and most 'overpopulated' countries most of the land is owned by tiny elites who use only a fraction of their holdings while the rest lies idle.

"And the rate of poverty is growing faster than the population is.

"What confronts us is not some intractable result of Malthusian biology, enough to make anyone feel helpless -- it's simply injustice. Injustice can be stopped in its tracks. And you don't have to be Nelson Mandela to do it -- everyone has something valuable to contribute.

"Change is in the air, the tools are at hand. We hope Journey to

Midori fixing a leaking tank on her Land Rover 109 -- what a struggle!

Forever will give people -- anyone with a computer, and especially schoolkids -- the chance to prove for themselves that they can make a difference.

"It's called Journey to Forever because mankind does have a future and there is a way forward, or many ways forward. The traditional societies have sustainable systems that lasted for thousands of years, and we have to learn from them, as it says very clearly in Agenda 21, the Earth Summit declaration of 1992.

"But we can do better than that. Another of the extremes of our times is that never before have we had so much sheer knowledge within our grasp.

The Beach House and the neighbours

We can mix the old with the new, in whatever ways work best and fit well, with the community and with the environment, and not only re-establish the traditional balance between Man and Nature, but fix what we've broken. Then we can all live forever."

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Keith Addison

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The team

The full expedition team will comprise 5-6 members. Handmade Projects fully intends that the project will be completed and the expedition will arrive in Cape Town having accomplished its mission. Thus nothing is indispensable -- equipment and vehicles will be replaced if needed, and so will team members, including core members, should they be unable to continue for any reason.

All team members will fill multiple roles. Qualifications include some or all of the following: communications and media skills, education/teaching skills, languages, rural development/agricultural skills (especially small-scale, traditional), forestry, healthcare/first aid, practical skills, mechanical skills, and general usefulness.

Teaching mainly concerns the Journey to Forever schools projects; in the context of development work in Third World villages, learning is much more important than teaching if the outcome is to be a good one.

Visitors

It is planned that schools project members, special supporters, media personnel and expert specialists will occasionally join the expedition, usually for brief periods, and not numbering more than two extra people.

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(**Bold-letter links** take you to the project introduction on the Schools Projects page)

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- School composting

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The Beach House fish pond

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Life as the only Japanese reporter on an English newspaper in Hong Kong

The team

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Community development

"Change not Charity!" say Journey to Forever's friends at Oxfam Hong Kong. Their clear and simple briefings on development get straight to the heart of the matter. We've summarized some of them here.

Oxfam Hong Kong
http://www.oxfam.org.hk

Poverty Alleviation -- Solutions

Change not Charity -- Charity and welfare can create dependency. We believe in helping people to help themselves.

A child dies every 3 seconds from hunger related causes -- Oxfam HK

If aid or development were simply a welfare exercise of handing over money, then the poor could become more dependent on outside help, less able to help themselves, and ultimately less equipped to solve their own problems.

We aim to support the efforts of people in finding their own solutions to poverty, rather than imposing solutions. When communities work together to improve their own lives, the result is a permanent strengthening of the community and renewed hope for the future. For this reason, we promote the principles of **Participation**, **Empowerment** and **Sustainability**.

Participation

We help those who are striving to help themselves. All our projects try to involve the beneficiaries at each stage of the project. **Participation** means that the poor people themselves are involved in identifying the problems they face, determining ways to overcome them, designing realistic plans to achieve these goals, and carrying them out. Solutions devised and fulfilled by the people in need are far more likely to prove successful than those imposed from outside.

Empowerment

From **participation** grows **empowerment**. People who truly participate in their own development are permanently strengthened. As well as better incomes or more crops, projects

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help to improve the skills and the experience of those involved. The project should also help build up more self-confidence and hope in the participants -- confidence that they can make a difference and that they can improve their lives. If projects can give poor people confidence, hope, dignity and strength, they will strengthen people more than any short-term financial help could ever do.

Sustainability

Participation and **empowerment** seek to ensure that projects bring lasting change which will strengthen people's ability to fend for themselves and improve their lives long after the project has ended and the overseas money has stopped. Therefore, another key principle is **sustainability** -- a long-term approach that seeks to understand and respect local conditions. We support projects which draw on the vibrant cultural traditions of the people with whom we work, projects which give a voice to all members of the community, and projects which ensure that the natural resources and the environment of the people are protected and sustained.

The Questions: Eight questions that will tell if a community will truly benefit from a development project.

Rural Reconstruction

This is the Credo of Rural Reconstruction, developed by Dr. Y.C. James Yen:

> Go to the people
> Live among them
> Learn from them
> Plan with them
> Work with them
> Start with what they know
> Build on what they have
> Teach by showing
> Learn by doing
> Not a showcase
> But a pattern
> Not odds and ends but a system
> Not to conform but to transform
> Not relief but release.

It's also the credo of the **International Institute of Rural Reconstruction** (IIRR), a non-profit NGO devoted to

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improving the quality of life of the rural poor in the developing countries. IIRR was founded in 1960, growing out of the revolutionary grass-roots development movement founded by Dr. Yen in China in the 1920s. Beginning with a series of massive, highly successful literacy campaigns for peasants, Dr. Yen and his colleagues evolved an integrated, sustainable, people-centred development approach that came to be known as rural reconstruction.

"IIRR's strategy recognizes that the poor face multiple problems: lack of education, inadequate income opportunities, ill health, a degraded environment, political oppression. IIRR uses bottom-up, participatory, integrated strategies to address this interlocking nature of rural poverty."
http://www.panasia.org.sg/iirr/info.htm

IIRR Website:
http://www.iirr.org/

Credo

These are the principles that guide Journey to Forever:

- that the spirit of cooperation is the foundation of real growth
- that resources are better shared
- that all life is interdependent
- that the "law of the jungle" is symbiosis, not savagery
- that good fellowship is the human norm, not greed and narrow self-interest
- that conflict can be resolved
- that self-reliance at the community level strengthens the whole of society
- that poverty is **WRONG**, and can be reversed
- that there is enough for everybody except the greedy
- that waste is wasteful
- that the best things in life are not things
- that this must be the guiding spirit of the new millennium
- that we are not a minority in holding to these principles

See **Poverty and hunger** -- The causes of poverty, The myth of scarcity

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Rural development

If it's not broken, don't fix it

Journey to Forever covers an interesting range of technologies. We'll be using the latest high-tech communications equipment, powerful computers, digital cameras and high-speed satellite communications units that come in chic little magic boxes stuffed to the brim with microscopic wizardry.

Yet they're tough and rugged, very well built, which is just as well because if they broke we sure wouldn't know how to fix them.

For the rest of the project, that's a prime consideration: can you fix it yourself? Better still: can you make it yourself? Important questions for us when we'll be spending so much time far from anywhere, and even more so for the villages we work in when our main aim is to help increase local self-reliance wherever possible, and decrease dependence on outside resources. So we tend towards low-tech solutions. Small is beautiful.

The project vehicles will be as low-tech as possible -- there won't be million-dollar workshops full of electronic equipment in most of the places we'll be visiting. The vehicles must be tough, capable, built to last, and fixable.

The core of the project is even lower-tech -- the ancient traditional farming methods still used by villagers in many remote areas.

These old farming systems are also tough, very capable and built to last, and they've withstood the test of time -- some, like China's, have fed growing populations for thousands of years without ruining either the soil or the environment, by following Nature's ways and obeying her rules.

Such farming systems can be highly productive, and they're sustainable -- they can last forever. According to Agenda 21, the action plan agreed at the Rio Earth Summit in 1992, and many other authorities, these traditional methods and skills are a vital element in the environmental management of the future.

But the old ways are everywhere under threat by the modern world -- much accumulated wisdom and many skills are already lost.

Agenda 21 calls on governments to "foster traditional methods and knowledge of indigenous people and their communities" (Agenda

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21, Section II, Chapter 15).

Related documents state: "Sustainable agriculture respects the ecological principles of diversity and interdependence and uses the insights of modern science to improve rather than displace the traditional wisdom accumulated over centuries by innumerable farmers around the world."

Other resolutions are to "recognize the value and encourage the use of traditional sustainable knowledge; encourage local capacity to develop appropriate technology adapted to local skills, needs and environment".

Agenda 21:
http://www.igc.apc.org/habitat/agenda21/

We don't aim to "modernize" old methods, merely to help strengthen them where needed, and whether by modern means or old, or a happy combination of both, along with old techniques borrowed from other traditional systems elsewhere, or new ones developed by appropriate technology groups, depends on what works best and what fits well, with the community and with the environment.

Local people will be involved at all stages -- they're the ones to decide what's good for them. (See **Community development**.)

Fixing what's broken

The local context is all-important in environment and development work. Basically it is ecological work, and the one and only Law of Ecology applies: everything is connected to everything else.

This is why ready-made, pre-conceived, across-the-board solutions designed somewhere else so seldom work well. They take little account of all the interconnections, which are always different in each new context, and the resulting rash of unforeseen side-effects soon add up to worse problems than the one they set out to solve in the first place.

We'll have some powerful tools with us -- things like power saws driven by our vehicle motors can do a week's work in half a day. But should we use them? In the wrong context, they could be extremely disruptive, even destructive. We'll also have hand saws, ancient tools like hoes, sickles, scythes -- and even the high efficiency of a scythe can be disruptive.

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Japan

Learning the local context takes time -- time we won't have. We're planning to make dozens of stops along the route, stopping for a month or so at a time to work on small-scale rural development projects. But, to avoid the context trap, we'll always be working for local NGOs on their projects.

We'll rely on the NGOs for their vital local knowledge. It will be pre-arranged: they'll already know what they want us to do for them and we'll come prepared. We'll also have access to sound advice and information on a case-by-case basis from online collaborators worldwide, via the Internet and our mobile satellite link.

Where practical, we'll always prefer low-tech solutions that rely on local skills and local resources, cutting down on imported inputs and keeping innovations to a necessary minimum.

Much of our work will be less sensitive, such as general repairs and maintenance to tools, walls and fences, paths, drains and ditches, livestock pens, housing, food storage. The repairman's always welcome! Especially if it's free.

We hope to gather long-term support for the NGOs we work with through media and other exposure as we record the journey and our projects (the team includes professional journalists). We'll link them with each other and put them in touch with international resources, and we'll maintain our links with them after we leave.

These are the areas we'll be focusing on:

- Waste recycling
- Soil management and erosion control
- Fertility improvement
- Pest and weed management
- Yield and crop-quality improvement
- Livestock management
- Water conservation
- Crop-livestock integration
- Tree farming -- people's forestry
- Energy
- Micro-credit schemes/women's issues
- Family nutrition
- Available/traditional healthcare

Our route between stops will be more flexible, with many shorter stops and detours for investigation and reporting as we continue

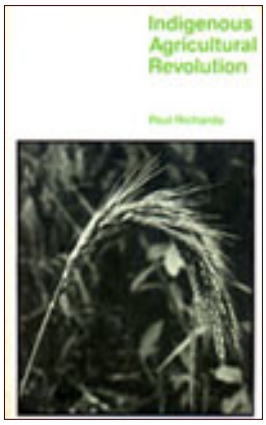
our environmental health check of the land and its people.

We'll also foster community-based projects in market towns and urban centres along the route, such as community gardens and urban farms, waste recycling and biofuels projects, establishing ongoing information-sharing networks between different centres. This will include both local schools and our schools network.

References

China's farming system: See the classic "Farmers of Forty Centuries, or Permanent Agriculture in China, Korea and Japan", by Prof. F.H. King, Chief of the Soil Management Division, US Department of Agriculture, Jonathan Cape, London, 1926, reissued in 1990. King was a brilliant agricultural researcher and the record of his journey through China, Japan and Korea a hundred years ago makes fascinating reading, both for its agricultural history and as a travelogue.
Recently republished in hardback by the Rodale Institute:
http://rodaleinstitute.org/bookstore/products/farm_books/main.html
Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

City farms: "Because of the pivotal role of women as food producers, investing in women farmers in cities is more likely to improve the nutrition and health of their families than investing in male farmers. Urban agriculture in the hands of women is a powerful tool to uplift women's social position as well as to improve their families' diets, incomes and food security" -- "City Women Farm for Food and Cash", International Ag-Sieve, Volume VI, No 2, 1993, Rodale Institute. Back issues are available for US$3 per issue, $1 each for more than six issues, the whole set of 36 issues for $35. Now published in book form, includes articles on green manure, agro-forestry, irrigation, biological pest control, erosion and more -- 26 assorted articles, from 1989 to 1995. From Rodale Institute Bookstore:
http://rodaleinstitute.org/bookstore/products/farm_books/9.html



"Leave the farmers alone" -- a review of **"Indigenous Agricultural Revolution -- Ecology and Food Production in West Africa"**, by agricultural researcher Paul Richards (1985). Richards delivers a damning critique of agricultural scientists' research in developing countries as out of touch with the needs of the majority of farmers. He says the capabilities of the peasants themselves have been grossly underrated, showing them to be ecologically aware, with sound reasons behind most of their techniques, and much given to experiment and innovation. Richards details several cases where scientific studies have "re-invented" techniques already widespread among peasants. A thoughtful, practical and thorough approach to how development should be tackled if projects are not only to "work" but to provide satisfactory answers to the questions "who benefits?" and "at whose expense?".

"Farmer First: Farmer innovation and agricultural research" edited by Robert Chambers, Arnold Pacey and Lori Ann Thrupp, 1989, 1998, Intermediate Technology, ISBN 1853390070
This book argues that farmers in resource-poor areas are innovators and adaptors, and that agricultural research must take the farmers' own agendas and priorities into account. Robert Chambers is one of the champions of indigenous agricultural development and the people-oriented approach. The "Farmer First" movement was at first dismissed by mainstream development workers as "naive populism", but most of them have since had to change their tune about that. From IT Publications:
http://www.developmentbookshop.com/book.phtml?isbn=1853390070

"Two Ears of Corn: A Guide to People-Centered Agricultural Improvement", by Roland Bunch, 1982, 3rd edition 1997
Bunch makes a similar point to that of Paul Richards (above). He worked with World Neighbors, a small private voluntary agency cooperating with a wide variety of local, national, and international organizations to improve the productivity of small farmers. A combination of widely varying experience and in-depth feedback helped World Neighbors select and refine a set of techniques that greatly increased the impact of many of its programs:

People-Centered Agricultural Improvement, the subject of this book. Now in its third edition, with its techniques taken up and being used all over the world. From ECHO's Global Bookstore: http://echonet.org/shopsite_sc/store/html/TwoEarsCorn.html

"Recording and Using Indigenous Knowledge: A manual", International Institute of Rural Reconstruction (IIRR), 1996, ISBN 0-942717-70-8
Rural people have an intimate knowledge of many aspects of their surroundings and their daily lives. Over centuries, people have learned how to grow food and to survive in a sometimes difficult environment. They know what varieties of crops to plant, when to sow and weed, which plants are poisonous and which can be used for medicine, how to cure diseases and how to maintain their environment in a state of equilibrium. This "indigenous knowledge" -- "IK" for short -- is a valuable resource for development: it can be equal to or superior to the scientific know-how introduced by outsiders. This manual provides rural development workers with the information and tools they need to integrate IK into their development work. It focuses on IK in People-Centered Agricultural Development. Full text online: http://www.panasia.org.sg/iirr/ikmanual/

"Indigenous practises are sometimes not very spectacular. Despite their effectiveness, they can easily be overlooked.

"For example, a traditional irrigation system consisting of mud canals and bamboo pipes looks less impressive than an introduced system of neat, straight, and cemented canals. Nevertheless the local system can effectively distribute water to the fields. In the long run, it might even conserve water better than the cement canals. Research in Nepal has shown that farmer-managed irrigation systems based on indigenous knowledge resulted in higher agricultural productivity than systems built and managed by government agencies.

"IK is often overlooked because it seems 'messy' and so is not obvious to outsiders. For example, people in some places do not weed their plots in order to reduce soil erosion. An outsider might get the wrong idea and assume nobody is tending the fields." -- From "Recording and Using Indigenous Knowledge", IIRR

The **Village Earth Model** for Sustainable Village-Based Development: Poverty is a crushing weight for most of the rural poor as they search in vain for opportunities that continually elude their grasp. They live out their lives isolated from the resources which the rest of society enjoys. The Village Earth Model is

designed to address global poverty. It is based on a synthesis of the best development practices pioneered and tested over the past 50 years. The model is founded on the premise that lack of access to resources is the primary obstacle to building a better life, and that poverty is the symptom rather than cause of the problem. It holds that villagers already possess the seeds of their own development. Unlike traditional methods, it employs a bottom-up approach to development. It listens rather than dictates. It provides access to resources rather than aid. Pilot projects are underway in India and Indonesia.
http://www.villageearth.org/About/about_ve.htm

The **Indigenous Knowledge Homepage** hosted by the Centre for International Research and Advisory Networks (CIRAN) promotes the exchange of information within the International IK Network:
http://www.nuffic.nl/ik-pages/index.html

The **Indigenous Knowledge and Development Monitor** (IKDM) focuses on the role of indigenous knowledge in participatory sustainable development:
http://www.nuffic.nl/ciran/ikdm/index.html

The **Center for Indigenous Knowledge For Agriculture and Rural Development** (CIKARD) focuses on preserving and using the local knowledge of farmers and rural people around the globe:
http://www.iastate.edu/~anthr_info/cikard/

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City farms

> -- "The key to the future of the world lies in gardening. One individual with a digging fork and a small garden *can* make a difference" -- *from the Foreword, "Gardening For The Future Of The Earth", Seeds of Change, 2000*

That might sound very idealistic, and indeed it is, but consider these facts:

City farming is spreading fast -- city farms contributed 15% to world food production in 1993 and it's expected to grow to 33% by 2005. Some 800 million people worldwide were involved in urban agriculture in 1996, according to the UNDP, growing fruits, vegetables, and herbs, as well as raising livestock.

More than half of the poor people in developing countries now live in urban areas, up from about a third in 1988 -- only 12 years ago -- and still increasing.

Urban farming in Haiti -- AGUILA Urban Agriculture Research Network Latin America http://www.idrc.ca/cfp/aguila.html

Poor people in cities farm scraps of ground wherever they can grow something to provide some food and make some money -- and they save money they would have spent on food. City farming makes a hefty contribution to the fight against poverty and hunger.

It also makes a hefty contribution to environmental and public health. Every year 5.2 million people, including four million children, mostly in cities, die from diseases caused by unhygienic sewage and waste disposal,

City farming in Peru (AGUILA)

and urban waste production is growing even faster than urban populations: by the year 2025, urban waste production will have quadrupled.

City farmers play a major role in waste recycling, creating a closed system in which organic wastes -- from food, manufacturing and sewage -- are reused instead of festering in dumps and polluting waterways. Human waste is turned into compost, domestic wastewater safely irrigates many crops, and

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aquaculture stabilizes animal manure. In Mexico City many families keep pigs -- urban pig farmers recycle up to 4,000 tons of the city's food wastes every day.

And city farming empowers women, which benefits everyone. Women in a vegetable-growing cooperative in Bogota, Colombia, earn three times more than their husbands do.

Expansion

Cities cover only 2% of the Earth's surface, but consume 75% of its resources. Cities are black holes, they're swallowing our planet. But, more and more, they're turning green.

Jac Smit, President of the Urban Agriculture Network and co-author of "Urban Agriculture: Food, Jobs, and Sustainable Cities", paints a vision of what the world would be like if cities were nutritionally self-reliant: "As we consider a dominantly urban Earth early in the next century, in a world with less land and water per-capita, the return of agriculture to where we live presents us with a new paradigm.

"What if 'waste is food' and sewage and garbage were prime inputs to food production? What if the urban landscape were edible? What if vacant, waste land in cities were productive and enhancing the environment for living? What if urban areas were increasing biodiversity rather than diminishing it?"

Urban farming in Haiti (AGUILA)

It's happening. Growing your own food in cities has long been the way in Asia, and it's expanding enormously in Africa, Latin America, and all over the world.

All over the world urban food production is growing more rapidly than urban population -- in spite of urban drift.

In greater Bangkok, 60% of the land is under cultivation, 72% of all urban families are engaged in raising food, mostly part-time.

In Moscow, the share of families raising food more than tripled between 1972 and 1992, from 20% to 65%.

In Dar-es-Salaam in Tanzania the number of households engaged in food production grew from 20% to more than 65% between 1970 and 1990.

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Urban farming in Haiti (AGUILA)

In Argentina the number of participants in the community agriculture program grew from 50,000 to 550,000 between 1990 and 1994, and the number of supporting institutions grew from 100 to 1,100.

The area devoted to urban agriculture in Harare in Zimbabwe doubled between 1990 and 1994.

It's a true grassroots initiative of "helpless" people helping themselves. Yet they do need help, as much help as they can get -- help in learning the best and safest ways of recycling wastes and the best growing methods, and help in persuading governments and local authorities to support their efforts rather than neglecting them, or even harassing them for occupying public land or land legally zoned for urban use, not agriculture.

Developed nations

City farming is growing just as rapidly in the rich cities of the West, perhaps more because of environmental concerns, but also to feed the hungry: the Urban Agriculture Network was "founded in response to the increase of persistent hunger in urban areas in both poor countries and rich countries".

Visitors take part in horticulture therapy at City Farmer's community garden

The city farming movement has been intensely studied in the 20 years or so that it has burgeoned in the Western cities, and it has been found to deliver a rich harvest of benefits -- benefits that social workers, community organizations, educators, psychologists, health workers, nutritionists and crime fighters can only dream of where there are no city farms or community gardens.

> -- "Ideally we believe that simply by changing from suit to jeans, digging up a bit of lawn, and planting vegetable seeds, the city person will begin asking questions about his environment and about his urban behavior and thinking patterns" -- founding directors of City Farmer, addressing science teachers at the 20th International

Science Education Symposium in 1979

By 1994, 300,000 households in the US were using a community garden, and 6.7 million more said they'd do so too if there was one nearby (National Gardening Association).

The US government's Urban Gardening program estimates that a $1 investment in food growing projects yields $6 of produce.

Gardening for dollars, Americans go green, Reuters, Washington, May 9, 2002 -- Home gardening is huge. Chalk it up to aging boomers, post-Sept. 11 nesting, or just demand for really fresh cilantro and tomatoes; Americans will spend some $28-billion on their food and flower gardens this year, according to the National Gardening Association.
http://www.planetark.org/dailynewsstory.cfm/newsid/15878/story.htm

Vermiculture Improves Urban Farming in Argentina -- Impoverished citizens of Rosario, Argentina's third largest city, are stepping up efforts to farm in urban neighbourhoods -- by using California red worms. Vermiculture (a method of composting fruit and vegetable waste using earthworms) is proving to be an inexpensive and easy way to create high-quality organic fertilizer. It is also helping improve the local environment.
http://www.idrc.ca/reports/read_article_english.cfm?article_num=1087
See **Vermicomposting**

Everybody benefits, but some of the main beneficiaries are the children. Community garden in Brazilia (City Farmer)

-- "1,631,694 files transmitted from our website for all of 1999, up 43% over 1998" -- City Farmer, Canada's Office of Urban Agriculture, January 2000

Journey to Forever will promote city farming and community gardening initiatives in all the urban centres we visit along our route.

See our **Organic gardening**, **Container gardening** and **Composting** pages.

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Resources for city farms

City farms

Organic gardening

Building a square foot garden
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- Raised beds and double-digging
- Paths
- The sides
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- Trellises
- Cement
- Soil
- No compost?

Plant spacing guides
No ground? Use containers
- Container gardening guide
- Resources

When to sow what

Organic gardening

-- "Organic gardening is not just a middle-class hobby. It's part of the wider environmental movement, it's part of a sustainable future. I believe that you could feed the whole world using organic methods." -- Jackie Gear, Executive Director of the HDRA, Britain's Organic Association, 1991.

-- "The truth, so effectively suppressed that it is now almost impossible to believe, is that organic farming is the key to feeding the world." -- "Biotech has bamboozled us all -- Studies suggest that traditional farming methods are still the best", The Guardian, August 24, 2000 http://www.guardianunlimited.co.uk/Archive/Article/0,4273,4054683,00.html

-- "Organic farming could produce enough food to feed large populations, according to British scientists at the Festival of Science in Sheffield." -- "Organic farming can 'feed the world'", BBC Science, September 14, 1999 http://www.purefood.org/Organic/orgfeedworld.cfm

-- "Feeding the world?" Quietly, slowly and very significantly, sustainable agriculture is sweeping the farming systems of the world -- Jules Pretty, Director of the Centre for Environment and Society at the University of Essex, examines the myths and realities of sustainable farming's quiet revolution. http://members.tripod.com/~ngin/article2.htm

"It sounds like an environmentalist's dream. Low-tech 'sustainable agriculture', shunning chemicals in favour of natural pest control and fertiliser, is pushing up crop yields on poor farms across the world, often by 70 per cent or more. But it's no dream. That's the claim being made in the biggest ever survey of green-minded farming. The findings will make sobering reading for people convinced that only genetically modified crops can feed the planet's hungry in the 21st century. The gains are greatest among poor farmers..." -- "The

Sowing times for different regions
Seed sowing and harvesting times for Hong Kong
Vegetable Garden Calendar for Hong Kong
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Catalogs
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greener revolution", New Scientist, 3 February 2001

Journey to Forever organic garden

Part of the Journey to Forever garden

We built an experimental garden at our base at the Beach House in Hong Kong, an interesting mix of Square Foot Gardening and Container Gardening, advanced yet simple and flexible organic growing systems. Though initially developed mainly for city-dwellers (parts of our garden came from a scaled-down version used in a 450-sq-ft 19th-floor city flat with no balcony), we'll be using these methods very far from cities.

Brimming with healthy vegetables

These systems need less space and less work, they're cheap, and they produce high yields of top-quality food.

One square foot garden unit measuring only 16 sq ft holds an average of 130 plants and produces enough high-quality vegetables for one person. It doesn't have to be a single unit, two half-sized units will do just fine -- or whatever fits.

> -- "The square foot garden is divided into a size and shape that gardeners of all ages, sizes, and levels of experience can understand and cope with easily. The system is simple but versatile. It can be adapted to fit all kinds of gardening situations" -- Mel Bartholomew, author of "Square Foot Gardening" (1981)

There was no garden at the Beach House before, just a big cement patio overlooking the sea, and under the cement, three metres of beach sand.

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A stunted umbrella tree (Elephant's Ear) was trying to grow in a hole in the cement, with some old bathtubs and tyres standing here and there where a previous tenant tried raising some vegetables. But most of the soil in them washed away in the rains.

Keith digging through the cement patio to build the growing beds

Soon we had tons of fertile soil in deep raised no-dig growing beds and hundreds of happy looking plants growing in them, with scores of varieties in square feet in the beds and in the containers. Our tomatoes grew more than 12 feet tall!

Squashes growing in a bathtub

Bananas and papayas grew in big baskets and Chinese dragon pots, a mulberry cutting grew to a three-metre tree in a sunken bathtub, squashes and gourds in baskets and another bathtub grew up old bamboo ladders onto the kitchen roof. Sweet potato vines sprawled over the patio from a bed made of old logs on top of the cement. A variety of greens, bush beans, dwarf peppers and cherry tomatoes thrived in special one-square-foot baskets -- a novel way to start your own portable garden.

The garden attracted lots of hardworking bees, many sorts of butterflies, toads to eat the bugs, and a lot of different birds -- a rich, balanced ecology.

Handmade soil

The Beach House garden demonstrates that you can build a beautiful organic food garden even on cement without any soil -- you make your own high-quality soil by **composting** food scraps with crop wastes and other waste-products. This waste recycling system is clean, hygienic and nuisance-free, and proven to be safe for children and in the home.

If you have garden space, so much the better -- this is how to get a LOT of good, healthy food out of a very small area with a minimum of fuss.

Education resources on the Web
Children's poetry

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Ichijima
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Turning a compost pile at the Beach House

If you only have a balcony or a roof, you can build a **container garden**. If you don't even have that you can make a window garden, and extend it by using grow-lights in the odd spare corner, and still grow a lot of your own food.

Whatever your situation, you can still make your own organic soil out of food scraps, grow your own healthy food, and do your bit to reduce waste.

> -- "You can raise a surprising amount of food on your roof, deck, patio or windowsill. The rewards can be large, even if your space is small" -- Chuck Crandall and Barbara Crandall, "Movable Harvests" (1995)

Other settings

This growing system is ideal for schools gardens and as a resource for school biology and environment projects.

In the US the Square Foot Foundation is working to get a garden in every school, with Internet resource links promoting inter-school collaboration and providing expert support.

Midori transplants seedlings, using yoghurt pots, paper cups and milk cartons.

In Britain the HDRA's newly launched Schools Organic Network is helping schools to start and manage organic gardens for education. "Today's children could be forgiven for thinking that bananas come from boxes, peas come frozen in packets, and tomatoes from tins. The real origin of these foods -- that they come from living plants which grow in the soil -- is not apparent." http://www.hdra.org.uk/schools_organic_network/index.htm

Our food-growing and waste-recycling system can also be easily adapted to the community gardens we plan to start in towns along our route.

And the garden served as a test-bed for some of the techniques and approaches we'll use in village rural development projects.

Village development

Why do small farmers need kitchen gardens? Because they help to ensure the family's food security.

There have been cases where development efforts have succeeded in increasing farm yields and productivity but this has led to a decrease in the family's nutritional status. In many societies weeding is "women's work", and more crops meant more weeding, and less time to tend the family vegetable patch (also women's work), and therefore less food for the children.

Close spacing creates a living green mulch to protect the soil.

Square foot gardening is an engineer's solution to the problem of how to grow enough food for your family with the minimum waste of space, time, work and resources while getting the best results.

One square foot garden unit measuring 4ft x 4ft -- only 16 sq ft -- will produce enough high-quality vegetables to feed one person every day.

We'll try to build at least two of them everywhere we go, in addition to whatever other work the local communities want us to do for them.

UPDATE

Since we wrote this we've found that other groups are using this approach, and it's very effective:
"In Kenya, the Association for Better Land Husbandry found that the farmers who constructed double-dug beds in their gardens could produce enough vegetables to see them through the hungry dry season. According to a review of 26 communities, 75% of the households are now free from hunger during the year, and the proportion of households buying food fell from 85% to 11%." -- **Alternative Models (or Approaches) to Food Production**, by Jules Pretty and

Rachel Hime, University of Essex, UK, Jean Marc von der Weid, AS-PTA, Brazil, October 2001
http://www.forumfoodsovereignty.org/ingleseweb/documenti_forum/documenti_base/alternative.htm

Technology

Like most Journey to Forever projects, the emphasis is on a mix of technologies. Gardening is an ancient art with a great heritage, and gardeners haven't mechanized like farmers have -- they still tend each plant one by one, the same old tried-and-trusted way. The square foot system just makes it easier.

All the local villagers liked our garden

We also use some sophisticated bio-control, waste recycling and soil bio-activation techniques, but they're easy to grasp and simple to use.

Many of the local villagers in Lantau still grow their vegetables the old way, and at first they were sceptical of our garden, with all that sand underneath. But when they saw the results they thought it was great, they kept saying so.

Rows are for tractors -- it's hard to see how they benefit gardeners. We planted a deep growing bed in circles. Circle-planting optimizes companion planting, successions and plant spacings for different plants. It's highly productive but needs a very fertile soil, and it's much more complex than square foot gardening

The square-foot idea is easy to grasp. Any farm women only has to see a square foot garden to understand how the system works, and can easily adapt it to local crops and conditions: deep, no-dig, raised beds; a different crop in each one-foot square; small plants in the front (facing the sun), bigger ones in the middle, climbers up a trellis at the back.

Apart from a **companion planting** chart (some plants love each other, others hate each other), a **plant-spacing chart** showing how many of

each species to plant in one square foot, and a **cropping calendar**, that's really all you need to know.

The circle bed in full production -- high yields of top-quality vegetables and herbs

Soil fertility

The key is to make the soil fertile enough to keep pushing up that many healthy plants -- square foot gardens need rich soil, at least 12 inches deep (these beds "grow" themselves deeper), or 16 cubic feet per unit.

So we'll also build two compost heaps (at least!). There's always enough waste material around to make compost.

Different crops grow well together -- high fertility allows for close spacing

One heap will be a quick-acting one -- we'll put a cubic metre (half a ton) of wastes through a power shredder, greatly increasing the surface area of the material and speeding up the rate of decay. Rapid bacterial breakdown will drive the temperature inside the heap well above 60 deg C within a day.

After a week we'll shred it again, and a week after that it will be ready -- rich, black, crumbly stuff that looks nothing like its origins and has a clean, earthy smell, the ideal soil, enough to build our two demonstration square foot units and plant them. No need for expensive chemical fertilizers!

But few villagers have power shredders, so at the same time we'll make another heap the low-tech way, in layers, which works just as well but takes longer to cure. This heap will get just as hot after a couple of days, and after two weeks we'll turn it, using ordinary hand tools, mixing it in thoroughly. A few weeks later it will be ready for use.

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Vermicomposting

Composting

Garden guides often describe composting as "nature's way" of recycling. Not so -- you just don't ever find large amounts of organic matter with the correct carbon-nitrogen ratio, water content and aeration carefully piled up by bears or gorillas working away in the forests with a compost fork and a watering-can, leaving it cooking away at high temperatures and emitting jets of steam. Nature doesn't make compost. Nature mulches.

Composting is indeed a *natural* way of recycling, harnessing natural processes rather than machinery and man-made chemicals, but it takes people to do it.

You could argue that machinery and man-made chemicals, and indeed Genetically Engineered organisms and nuclear warheads also harness natural processes, and so they do, but you wouldn't claim they were "natural". "Natural" probably means something nature approves of. Does nature approve of compost, or is it a distortion of natural processes?

Healthy plants growing well with plenty of good compost at the Journey to Forever organic garden

If you watch carefully to see what nature does as she goes about her daily round of chores, it's quite easy to start believing that the whole thing is a complicated, secretive conspiracy by soil micro-organisms to beget more soil micro-organisms. Nature's first concern is always to build more topsoil, and to protect it. It's easy to see why: no topsoil, not much nature either. The Earth's green carpet of living things is really just the Soil Creature's skin.

> A single spade full of rich garden soil contains more species of organisms than can be found above ground in the entire Amazon rain forest.
>
> Although the soil surface appears solid, air moves freely in and out of it. The air in the upper 8 inches of a well-drained soil is completely renewed about every hour.
>
> -- Soil Factoids, US National Soil Survey Center

It's estimated that a human with a compost fork and a watering-can,

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carefully piling up organic matter with the correct C/N ratio, water content and aeration so that it cooks away at high temperatures and emits jets of steam, can make as much topsoil in a year as nature can make in a century, and nature definitely approves. You can tell when nature's happy, the plants smile at you. When she's not happy you can tell by all the "side-effects". Try it and see. Any gardener can quickly learn to make compost.

> -- "Man's work with Nature that furthers Nature's aims is the work that rewards him the best." (I-Ching)

Exceptions

It's not quite true that nature never makes compost. There's an Australian bird that carefully assembles large piles of organic matter to nest on, mixing it up with droppings -- arguably a compost pile. It even generates warmth, which helps to hatch the eggs. And termites build tiny compost piles deep underground from pulped wood to make the special soil needed for the fungus farms that produce the only food they can eat. Sometimes there are even manure worms in attendance at the compost site. Termites could be the world's most scientific composters.

Compost and organics

Soil maintenance is at the heart of organic growing: don't feed the plants, feed the soil -- the plants will look after themselves. The extremely complex subject of soil maintenance can happily be summed up in one word: composting.

> -- "Producing quality compost is the most important job on the organic farm. A lot of the problems I see on farms I visit could be solved by making better compost." -- Elliott Coleman, **The New Organic Grower**

What lives, eventually dies, and its substance returns to the soil to be recycled into new life. This is nature's law of return. Organic growers greatly enhance the last part of the process by composting crop and other organic "wastes" before the soil receives them. Well-made compost is the ideal soil-food. This is how impoverished, sick soils can be restored and maintained at high levels of fertility.

The cycle of growth and decay is often depicted as a wheel, where birth, growth and maturity take place above ground in the light, and the processes of decay below the surface in the darkness, giving birth to life anew. If growth is faster than decay the wheel is broken, destroying nature's balance. Composting accelerates the decay process while maintaining the balance of the wheel -- growth follows automatically as the wheel spins faster.

> -- "Growth has been speeded up, but nothing has been done to accelerate decay. Farming has become unbalanced. The gap between the two halves of the Wheel of Life has been left unbridged, or it has been filled by a substitute in the

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shape of artificial manures (chemicals). The soils of the world are either being worn out and left in ruins, or are being slowly poisoned. The restoration and maintenance of soil fertility has become a universal problem." -- Sir Albert Howard, Farming and Gardening for Health or Disease (The Soil and Health), Faber and Faber, London, 1945

"I know it sounds simplistic," says Keith, "but whatever problems you're having, the first solution is compost -- more and better compost. Pests or disease? Compost will fix that. Weeds? Compost will fix that too, along with mulching -- best of all, in permanent raised beds with fertile soil you can plant so close that the crops themselves form a living green mulch, maintaining a humid zone just above the soil. No weeds, no problems at all -- but it needs lots of good compost.

"Not enough water? Drought? Compost will fix that as well -- it greatly increases the soil's water-holding capacity.

"Too much water? I had an old rice field that was so badly clay-panned from years of overashing that it was still waterlogged after four months without rain, only rank grass would grow there. Compost and weeds fixed it. I cleared it and sowed a lot of wild sunnhemp seeds, and compost gave them a start.

Those deep roots went down right through the pan. The villagers thought I was crazy -- I had the best crop of weeds in the valley. But sunnhemp's good fodder for livestock, and good compost material, and it's a legume so it fixed lots of nitrogen in the soil. You could grow anything in that field after that."

The best crop of weeds in the valley

What a useful weed!
Sunnhemp -- Crotalaria juncea (James A. Duke, 1983, Handbook of Energy Crops, Purdue)
http://www.hort.purdue.edu/newcrop/duke_energy/Crotalaria_juncea.html

100-Year Drought Is No Match for Organic Soybeans
KUTZTOWN, Penn. (November 8, 1999) -- After one of the worst droughts on record, the harvest for many farms in the US has been a disaster. But one farm is celebrating: "The yield from our organic soybeans is outstanding," says Jeff Moyer, Farm Manager at The Rodale Institute's Farming Systems Trial in Kutztown, Pennsylvania. Using replicated plots the trial compares highly productive, intensive soybean systems under conventional and organic management. Figures just released show yields of 30 bushels per acre from the organic soybeans compared to only 16 bushels per acre from conventionally-grown crops. Improved soil quality under organic management is credited for the high performance of Rodale's organic crops in the drought.

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http://rodaleinstitute.org/global/11_9_99.html

"The testing we have done so far here in the U.S. and in Vietnam and China has shown that disease suppression, both foliar, limb and root, is more closely associated with mature compost that has a wide range of bacterial and fungal components...

"In Vietnam, there is a disease of citrus called "Greening Disease". It has become a major concern in Asia and now in the United States. No known cure. The solution to date has been to cut down the trees, burn the rubble and replant with a different crop. Our tests have regrown new foliage, sent the diseased trees into blossom and produced unaffected fruit. The same product has produced rice with no chemical inputs and no sign of disease. In Arizona and Arkansas, the same product has controlled cotton root, rot blight pythium and fusarium wilts and nematodes. In China, potatoes from infected fields showed no signs of disease after using the same product.

"I could go on and on. The point being, disease suppression seems to be a function of balance in the microbial population. It is the imbalance introduced by modern farming practices that create the problem."
-- Phil Fredericks
http://www.ecticompost.com
("WASTENOT Organic Waste Collection, Processing, Composting" list, 5 Jan 2001)

See:
Brix levels
No sugar

What is compost?

A smelly hole at the far end of the garden filled with putrefying kitchen wastes and flies buzzing round. That's what compost ISN'T. No stinks, no flies, though kitchen wastes are welcome.

Compost is not just decayed organic matter. Composting is applied microbiology at its most complex, involving the interactions of thousands upon thousands of different species of microorganisms (2 million individuals per gram) in a highly complex ecosystem. The composting process kills weed seeds and suppresses human and plant pathogens; that doesn't happen when leaves and other detritus rot down on their own.

Once applied, compost "balances" the soil flora: that is, for each of the scores or more of disease organisms that can affect each species of plant, at least 12 to 15 different species of bio-control microorganisms need to

be present, with the food and conditions they require, if the plant is to be healthy. Composting accomplishes that, among other things.

Worn-out soil, grey and lumpy

The same soil tranformed, after a very light composting and a sweet potato crop (shared with a family of bandicoots, but there was plenty for everyone)

For more about soil microorganisms and the vital role they play, see "The Living Soil: Importance of Soil Organisms" in the Sustainable Soil Management Soil System Guide by the Appropriate Technology Transfer for Rural Areas (ATTRA) in the US:

"One of the major benefits bacteria provide for plants is in helping them take up nutrients. Some species release nitrogen, sulfur, phosphorus, and trace elements from organic matter. Others break down soil minerals and release potassium, phosphorus, magnesium, calcium and iron. Still other species make and release natural plant growth hormones, which stimulate root growth.

"A few species of bacteria fix nitrogen in the roots of legumes while others fix nitrogen independently of plant association. Bacteria are responsible for converting nitrogen from ammonium to nitrate and back again depending on certain soil conditions. Other benefits to plants provided by various species of bacteria include increasing the solubility of nutrients, improving soil structure, fighting root diseases, and detoxifying soil."

Other soil organisms covered: earthworms, arthropods, fungi, actinomycetes, algae, protozoa, nematodes (mostly beneficial): "All these organisms -- from the tiny bacteria up to the large earthworms and insects -- interact with one another in a multitude of ways in a whole soil ecosystem." Total weight of soil organisms per acre of healthy topsoil: about 4 tons.
http://www.attra.org/attra-pub/soilmgt.html#organisms

Real composting has been a scientific process since the 1930s. In fact it's nothing new -- the Spanish Arabs were master composters, and Chinese peasants have composted virtually everything for centuries. But science has made it a simple matter -- just follow the recipe. See **Making compost**.

See **Vermicomposting resources** for more information.

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Small farms

(Christine Thery)

Small family farms are the backbone of a community, a nation, and of society as a whole. A landscape of family farms is settled, balanced and stable, and generally sustainable. It's the natural shape of society on the land. Such communities aggregate into strong and secure nations.

But it's difficult to find a government that thinks that way, now or ever: the history of small farms presents a fantastic picture of neglect and abuse. Maybe the family farming landscape just doesn't offer enough opportunity for the rich and powerful, and the greedy.

Compare Rome before the Punic Wars, built on a bedrock of independent yeoman farmers, with Rome after the wars, the small farms swallowed by big estates owned by nobles and worked by slaves, a mighty empire with cancer at its heart, inevitably to fall.

> "The original strength of Rome, like that of China, was that of a superior family-agriculture." -- **"Restoration of the Peasantries"** by G.T. Wrench, Chapter 4 -- The Second Agricultural Path
>
> "If, by some magic, we could transport ourselves back to the days of the early Latin farmers, we should see a picture of a well-populated countryside with the land divided up into a number of small farms, often not exceeding five acres in extent." -- **"Reconstruction by Way of the Soil"** by G.T. Wrench, Chapter 2 -- Rome

Now it's industrialization that collapses rural economies, driving the farmers into factories and city slums, fodder for economic growth and a "development" that turns a country from food self-sufficiency to a producer of commodities with massive food import bills, an economic success story that can be wrecked by a run on the foreign exchange market.

The cancer at the heart of today's mighty industrial empire is the ruin that this woefully unbalanced landscape is wreaking upon both the natural and the social environment. It's not sustainable, by any measure, as everybody knows.

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"Global Agricultural Survey Shows Nearly Half of Farm Soil 'Seriously Degraded'" -- Associated Press, May 22, 2000. Detailed satellite photos of the Earth's land mass and other data are helping scientists at the UN-affiliated International Food Policy Research Institute determine the state of global agriculture. Their conclusion: nearly 40% of farmland is seriously degraded. Soil erosion, loss of organic matter, hardening of soil, chemical penetration, nutrient depletion, excess salinity and other damage have left much of the world's potential and previous agricultural land unusable. The research covers only human-induced degradation. See **Land Degradation In The Developing World: Issues and Policy Options for 2020**: http://www.ifpri.org/2020/briefs/number44.htm

The 1999 report on the University of Wisconsin-Madison's ongoing 37-year project monitoring the effects of nitrogen fertilisers in the US concluded that agriculture's continuing overapplication of nitrogen fertilizers is causing irreparable damage to the soil. It said US farms have "a 50% applied nitrogen efficiency rate" -- only half the nitrogen applied to the soil is actually used by the crop. The other half becomes harmful nitric acid. They said three decades of such overuse of nitrogen has destroyed much of the soil's fertility, causing it to age the equivalent of 5,000 years. -- **"Acidification From Fertilizer Use Linked To Soil Aging"**: http://www.cals.wisc.edu/media/news/03_99/acid_soil.html

"Crops without profit", New Scientist, 18 December 1999 -- Low-cost food, the great achievement of postwar high-input intensive farming, may be an illusion. The most detailed study yet of the industry's wider balance sheet has found the costs of cleaning up pollution, repairing habitats and coping with sickness caused by farming almost equals the industry's income. The true cost of £208 per hectare is double the amount suggested by previous, less detailed, studies of the costs in Germany and the US. But the survey's chief author, Jules Pretty of the Centre for Environment and Society at the University of Essex, describes this figure as "very conservative". Environmental economists say the findings suggest the need for a radical rethink of Europe's farming policy.
http://www.newscientist.com/hottopics/population/population.jsp?id=22171800

An assessment of the total external costs of UK agriculture, J.N. Pretty, C. Brett, D. Gee, R.E. Hine, C.F. Mason, J.I.L. Morison, H. Raven, M.D. Rayment, G. van der Bijl, Agricultural Systems 65 (2) (2000) pp. 113-136 -- this paper was this peer-reviewed journal's second-most-popular download of the year. The report: http://www2.essex.ac.uk/ces/ResearchProgrammes/Externalities/Externsubheadings.htm

"European Union Goes Organic to Tackle BSE Scare", February 13, 2001 (ENS) -- Organic farming is at the heart of a seven-point plan announced by the European Commission to tackle the continent's BSE (mad cow disease) crisis. The Commission called for a move away from industrial farming and increased support for

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extensive, organic agriculture. "The BSE crisis demonstrates the need for a return to farming methods that are more in tune with the environment," EU Farm Commissioner Franz Fischler's proposal said. The UK's Soil Association estimates that demand in the UK for organic food is growing by more than 40% a year and much of Europe is following the same trend.

"EU Women Ministers and 'Green' Agriculture", Financial Times, March 7, 2001 -- Margareta Winberg, Sweden's agriculture minister and president of the EU farm council, says Europe should move away from mass factory farming and beef up legislation designed to encourage small-scale, environmentally friendly organic farming. "We want to see Europe move toward extensive farming that is more natural and better for the environment," she says. Under her stewardship Sweden has set a target of turning 20% of arable land into organic farms by 2005 and Ms Winberg says other EU countries ought to do the same. The EU should create a community-wide target and "name and shame" those countries that refuse to comply.

"European Ag Ministers Support Organic Farming", May 14, 2001 (ENS) - Agriculture ministers from 12 European countries have called for creation within two years of a European action plan for the development of organic farming and food. Agreed at a conference in the Danish capital on Friday, the Copenhagen Declaration marks a breakthrough for the European organic movement, according to Denmark's agriculture ministry.

Many people see no choice but to abandon technology and revert to the miserable inadequacies of primitive existence, or face life on a ruined planet. But it's not inevitable that our society should follow Rome, and fall. And anyway it turns out that most people in most so-called primitive societies (actually they were very sophisticated at what they did, and still do in many cases) were neither miserable nor inadequate: they lived long and healthy lives and died at a sprightly old age with perfect teeth and no sign of arthritis. (Read **Weston A. Price**, if you want to argue about that.)

In fact we don't need to make such miserable either/or choices, we can have it both ways.

On the one hand, there's growing evidence that industry can change its ways and clean up its act, given the mounting public pressure since 1987 when "the environment" suddenly hit the headlines (for no known reason) and failed to go away again.

It seems we're not all just passive consumers after all, semi-animated lumps of sheer appetite living only for pre-packaged gratification. And in the meantime several hundred million of us have hooked ourselves and each other up to the Internet and are becoming ever more assertive and self-reliant. That won't go away either -- it's not a fashion, it's a trend, and the roots of it go back decades. And, most hopeful of all, the children care about the environment.

Trees and forests
The Beach House fish pond
HOMeR
Eco-footprint
School and youth programs on the Web
Education resources on the Web
Children's poetry

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Handmade Projects
Ichijima
Japan

Another discernible trend, with its roots going even further back, is the back-to-the-land movement. Primarily it's a change in attitude: city dwellers want closer ties with nature, with where their food comes from, with growing things. They're balcony or rooftop gardeners, backyard farmers, community gardeners, high-fliers opting out for Voluntary Simplicity and a more self-reliant life with real quality. And homesteaders, small farmers.

In the US, the number of small farms is growing by 2% a year. In the Third World the focus of rural development is shifting from mechanization and the (false) economies of scale to programs that strengthen small farmers and their indigenous traditional methods.

The landscape of the future is a sustainable one of small farms and self-reliant communities, of homeworking and homeschooling and networking, of well-greened cities that are no longer a cancer upon the land, and of an industry and technology that fits, with the community and with the environment.

Sustainable farming

-- "The criteria for a sustainable agriculture can be summed up in one word -- permanence, which means adopting techniques that maintain soil fertility indefinitely." -- *Lady Eve Balfour, "Towards a Sustainable Agriculture -- The Living Soil"*

-- "The maintenance of the fertility of the soil is the first condition of any permanent system of agriculture." -- *Sir Albert Howard, "An Agricultural Testament"*

-- "Organic gardening is not just a middle-class hobby. It's part of the wider environmental movement, it's part of a sustainable future. I believe that you could feed the whole world using organic methods." -- *Jackie Gear, Executive Director, HDRA, Britain's Organic Association*

Sustainable farming is not strictly defined as organic, and sustainable farms in the developed countries often use chemicals and techniques not permitted on certified organic farms.

But these farms are a vast improvement on the highly chemicalized, mechanized, specialized, industrialized factory farms they're replacing. And the more sustainable they become, they more organic they are.

But in the Third World development setting organic farming is THE appropriate technology to use. It fits all the requirements, making maximum use of locally available, renewable resources, and minimum or zero use of imported inputs. It achieves high yields of high-quality food, and marries happily with traditional techniques.

It sustains and builds the most precious resource of soil fertility, prevents erosion, maintains high levels of biodiversity, and is environmentally clean. It can have high or low labour inputs, depending on need and situation. It can

be adapted to any climatic, geographic, environmental or cultural conditions. It promotes community health and nutrition, and community self-reliance. It's the way of the future.

Journey to Forever core member Keith Addison first learnt and used organic methods 20 years ago as a sustainable system for Third World farmers. "Everything I've learnt since has confirmed that," he says.

Small farms fit

Sustainable farms are small. They're mixed -- mixed crops, mixed trees and mixed livestock, with all three mixed together in an integrated pattern that mimics natural biodiversity and reaps the benefits of collaborating with nature.

The main benefit is health: healthy crops and livestock, healthy soil, and healthy yields, along with low input costs.

This kind of farming is intense and needs close management, and since they're usually family farms, this is why they're small: a family can't manage a bigger farm properly.

Anyway, there's no need to: mixed family farms provide sustenance, food security and a healthy surplus for sale or barter -- they far out-produce the bigger, mechanized farms.

In Thailand, farms of two to four acres produce 60% more rice per acre than bigger farms. In Taiwan net income per acre of farms of less than 1.25 acres is nearly double that of farms over five acres. In Latin America, small farms are three to 14 times more productive per acre than the large farms. Across the Third World, small farms are 2-10 times more productive per acre than larger farms.

In the US, farms smaller than 27 acres have more than 10 times the dollar-per-acre output of larger farms. In Britain a recent study of the hidden costs of industrial farming raised the bill to £2.3 billion -- almost as much as the farm industry's total income.

In the US, small farms have three times as many trees per acre as larger farms, have more biodiversity and do less environmental damage. And since they're diversified, they're not tied to the vagaries of a single-product market.

Economies of scale might work in a factory, but on a farm it's just an illusion: agricultural economists now accept there's an "inverse relationship between farm size and output".

> "Small family and part-time farms are at least as efficient as larger commercial operations. There is evidence of diseconomies of scale as farm size increases." -- **"Are Large Farms More Efficient?"** Professor Willis L. Peterson, University of Minnesota, 1997. Abstract: http://ideas.repec.org/p/wop/minnas/9702.html
> Download (Acrobat file, 52kb):

http://agecon.lib.umn.edu/mn/p97-02.pdf

Industrial farming as a whole is based on an illusion: factory techniques are a poor substitute for nature's excellent arrangements. There's simply no need for them.

> **The myth of efficiency** -- Industrial agriculture claims "efficiency" and cheaper food. But it's a false promise. In farming, bigger is not more efficient. And if you count social and environmental costs, it's not cheap either... The situation is clear: Our conversion to industrial agriculture means subsidizing the richest corporations on earth to run a system that eliminates livelihoods, harms communities, poisons the earth, and doesn't feed the people, either. Maybe you pay a few pennies less for your industrial potato, but the next generation will pay billions more in taxes, to clean up the mess this system creates. This is not "efficiency." MSWord document:
> http://www.turnpoint.org/efficiency.doc

Chemical corporations will assure you that plant nutrients are plant nutrients, and they're exactly the same whether they come from soil humus or from a bag of chemicals, and chemical analysis confirms that.

Chemists can often find no difference between organically raised crops and chemically fertilised crops. Cows see a difference though -- they need much less food when it's grown organically, to produce the same amount of milk. Many farmers have confirmed this. "Cows are capable chemists," said the great soils scientist William Albrecht of Missouri. He also said: "Food is fabricated soil fertility."

Wise farmers are small farmers who listen to their cows.

References

"If we are concerned about food production, small farms are more productive. If our concern is efficiency, they are more efficient. If our concern is poverty, land reform to create a small farm economy offers a clear solution. The small farm model is also the surest route to broad-based economic development. If the loss of biodiversity or the sustainability of agriculture concern us, small farms offer a crucial part of the solution." -- Peter M. Rosset, Food First/The Institute for Food and Development Policy, **"The Multiple Functions and Benefits of Small Farm Agriculture"**, FAO/Netherlands, September 1999.
http://www.foodfirst.org/pubs/policybs/pb4.html
Condensed version: **On the Benefit of Small Farms**:
http://www.foodfirst.org/pubs/backgrdrs/1999/w99v6n4.html

See the USDA National Commission on Small Farms report, **"Time to Act"**, 1998 -- Executive Report Summary:
http://www.reeusda.gov/agsys/smallfarm/report.htm#execsum

"Our nation's economic foundation is built on the backs of America's small farmers. Their survival and success is not only important to their families, but

to consumers, rural communities, the environment, and the global economy." -- Former US Congressman **Harold Volkmer**, Chairman, USDA National Commission on Small Farms.

Many studies have shown that industrialized factory farms do not outyield organic farms.

One 15-year study found that organic farming is not only kinder to the environment than "conventional", intensive agriculture but has comparable yields of both products and profits. The study showed that yields of organic maize are identical to yields of maize grown with fertilisers and pesticides, while soil quality in the organic fields dramatically improves. (Drinkwater, L.E., Wagoner, P. & Sarrantonio, M. **Legume-based cropping systems have reduced carbon and nitrogen losses**. Nature 396, 262–265.) Acrobat file, 239 kb:
http://www.biotech-info.net/legume.pdf

A Rodale study found that organic farm yields equal factory farm yields after four years using organic techniques.

"In the USA, for example, the top quarter sustainable agriculture farmers now have higher yields than conventional farmers, as well as a much lower negative impact on the environment," says Jules Pretty, Director of the Centre for Environment and Society at the University of Essex, **"Feeding the world?"**, SPLICE, August/September 1998, Volume 4 Issue 6.
http://members.tripod.com/~ngin/article2.htm

New studies are finding that it's not industrialised farming or GMOs that will feed the world of the future.

Biotech has bamboozled us all: Studies suggest that traditional farming methods are still the best -- "The truth, so effectively suppressed that it is now almost impossible to believe, is that organic farming is the key to feeding the world." -- The Guardian, August 24, 2000
http://www.guardianunlimited.co.uk/Archive/Article/0,4273,4054683,00.html

"Organic farming can 'feed the world'" -- BBC Science, September 14, 1999
http://news.bbc.co.uk/1/hi/sci/tech/specials/sheffield_99/447337.stm

"Organic Apples Win Productivity and Taste Trials", August 10, 2001 -- A study in the journal *Nature* (19 April 2001) counters arguments that organic farming systems are less efficient and produce lower yields than conventional farming systems. Conducted by researchers at Washington State University from 1994 to 1999, the study compared organic, integrated and conventional apple orchards and found that while all three systems gave similar apple yields, the organic system had the greatest environmental sustainability, profitability and energy efficiency. -- Pesticide Action Network North America (PANNA)
http://www.panna.org/panna/resources/panups/panup_20010810.dv.html

"The Greener Revolution", New Scientist, 3 February 2001 -- It sounds like an environmentalist's dream. Low-tech "sustainable agriculture", shunning chemicals in favour of natural pest control and fertiliser, is pushing up crop yields on poor farms across the world, often by 70 per cent or more. A new science-based revolution is gaining strength built on real research into what works best on the small farms where a billion or more of the world's hungry live and work. For some, talk of "sustainable agriculture" sounds like a luxury the poor can ill afford. But in truth it is good science, addressing real needs and delivering real results.
http://www.biotech-info.net/greener_revolution.html

"An Ordinary Miracle", New Scientist, 3 February 2001 -- In the world's largest study into sustainable agriculture, Jules Pretty, professor of environment and society at the University of Essex (UK) analysed more than 200 projects in 52 countries. He found that more than four million farms were involved -- 3 per cent of fields in the Third World. And, most remarkably, average increases in crop yields were 73 per cent. Sustainable agriculture, Pretty concludes, has most to offer to small farms. Its methods are "cheap, use locally available technology and often improve the environment. Above all they most help the people who need help the most -- poor farmers and their families, who make up the majority of the world's hungry people."
http://www.biotech-info.net/ordinary_miracle.html

See: **"Reducing Food Poverty with Sustainable Agriculture: A Summary of New Evidence"** Centre for Environment and Society, University of Essex
http://www2.essex.ac.uk/ces/ResearchProgrammes/SAFEWexecsummfinalreport.htm

See: **"47 Portraits of Sustainable Agriculture Projects and Initiatives"** Centre for Environment and Society, University of Essex
http://www2.essex.ac.uk/ces/ResearchProgrammes/SAFEW47casessusag.htm

Cuba Leads the World in Organic Farming -- Cuba Leads the World in Organic Farming -- Faced with the possibility of widespread starvation, the Cuban government foresaw that a full-scale mobilization of domestic resources, both human and natural, would be required in order to increase production to meet the demands of a hungry populace. And with few options to import food given the stringency of the U.S. embargo, Cuba turned over a new leaf by converting almost entirely to an organic production system within 10 years. -- **Cuba's security in fresh produce**, ENN, September 12, 2003:
http://www.enn.com/news/2003-09-12/s_8194.asp

In 1990 Cuba's cheap supplies of grain, tractors and agrochemicals were cut off with the collapse of the Soviet Union. Pesticide use halved overnight, as did the calorie intake of its citizens. Strapped for cash, Cuba was forced to embrace low-input farming or starve. Today, oxen have replaced the tractors, and farmers have adopted organic methods, mixing maize with beans and cassava and doubling yields in the process, helping average calorie intake per

person rise back to pre-1990 levels. -- **"An Ordinary Miracle"**, New Scientist, 3 February 2001.

A group of Iowa farmers, professors, and students traveled to Cuba in June 2000 to view the country's approach to sustainable agriculture. Cuba relies on organic farming, using compost and worms to fertilize soil. "In many ways they're ahead of us," says Richard Wrage, of Boone County Iowa Extension Office. Lorna Michael Butler, Chair of Iowa State University's sustainable agriculture department said, "more students should study Cuba's growing system." -- AP, 5 June 2000

Despite the US embargo, Cuba has turned a severe food crisis into a sustained recovery in food production... Some have called Cuba a national laboratory in organic agriculture... Imports of pesticides and herbicides actually dropped from 1995 to 1998, yet food production rose over the same period... Forty years after the birth of the Cuban revolution, Cuba can claim greater diversity in its production and in its trading partners than it ever has had in modern history. Remarkably, Cuba has brought about this dramatic change in agriculture in the middle of a massive economic crisis.**"Cuba: Going Against the Grain"** -- Executive Summary:
http://www.oxfamamerica.org/publications/art1164.html

Sustainable Agriculture - A Case Study, Peter M. Rosset, co-director of Food First/The Institute for Food and Development Policy -- When trade collapsed with the socialist bloc in late 1989 and 1990, the degree to which Cuba relied on monocrop agriculture proved to be a major weakness for the country. Searching for the most efficient solution, the Cuban government launched a national effort to convert the nation's agricultural sector from high input agriculture to low input, self-reliant farming practices on an unprecedented scale. By mid-1995 the food shortage had been overcome, and the vast majority of the population no longer faced drastic reductions of their basic food supply. In the 1996-97 growing season Cuba recorded its highest-ever production levels for ten of the thirteen basic food items in the Cuban diet. The Cuban experience illustrates that we can feed a nation's population well with a small or medium-sized farm model based on appropriate ecological technology, and in doing so we can become more self-reliant in food production.
http://www.farmingsolutions.org/successstories/stories.asp?id=117

Use of ANY pesticides on most organic farms is minimal -- fewer than 10% of organic farms in the US use even the approved plant-based organic insecticides on a regular basis (see Walz, E. 1999, **Third Biennial National Organic Farmers' Survey**, Santa Cruz, CA: Organic Farming Research Foundation http://www.ofrf.org).

"Kicking the Chemical Habit" by Peter Rosset (Food First/Institute for Food and Development Policy), New Internationalist, May 2000 -- Giving the lie to the agribusiness myths that pesticides are indispensable or that large farms are somehow more productive than small farms.
http://www.newint.org/issue323/kicking.htm

Contrary to the modern practice of growing monocrops of one variety, mixed species of rice were planted in Yunnan, China, with control plots of monocultured crops. Disease-susceptible rice varieties planted in mixtures with resistant varieties had 89% greater yield and blast was 94% less severe than when they were grown in monoculture. The experiment was so successful that fungicidal sprays were no longer applied by the end of the two-year program. -- **"Genetic diversity and disease control in rice"**, Nature 406, 17 August 2000
http://www.mindfully.org/GE/Rice-Diversity-Yield.htm

A local Catholic priest in Madagascar stumbled on a system that raises typical rice yields from 3 to 12 tonnes per hectare. His trick is to transplant seedlings earlier and in small numbers so that more survive; to keep paddies unflooded for much of the growing period; and to use compost rather than chemical fertilisers. Some 20,000 farmers have adopted the idea in Madagascar alone. In tests of the system, China, Indonesia and Cambodia all managed to raise their rice yields. -- **"An Ordinary Miracle"**, New Scientist, 3 February 2001. See: **"Madagascar non-GE rice trials lead to agricultural revolution"**:
http://www.gene.ch/genet/2001/Jan/msg00083.html
The SRI revolution is sweeping the world -- see the **System of Rice Intensifcation Homepage** hosted by Norman Uphoff, Director of the Cornell International Institute for Agricultural Development (CIIFAD):
http://ciifad.cornell.edu/sri/
SRI FAQ (Acrobat file, 230 kb):
http://ciifad.cornell.edu/sri/qanda.pdf

It's worth noting that the two founding fathers of Organic farming, Sir Albert Howard in India and Rudolf Steiner in Europe, were aiming to increase yields, and developed organic farming methods as a result. They were not initially concerned with environmental protection or food safety.

See also **Why organic?**
The case for organics: Scientific studies and reports

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Biofuels

"How can you say you're environmentalists?" asked a local sceptic in Hong Kong. "Your Land Rovers aren't green at all -- one runs on leaded petrol and the other's a dirty diesel."

"Um," we said, thinking fast... "but if everyone had cars like ours, there'd be no need for roads."

In fact no car built today has such low manufacturing eco-costs as a Series Land Rover. And these old Land Rovers last and last: "My Land Rover is 41 years old and has prevented the need to build at least five replacements during that time." -- Series I owner, England, Land Rover Owners Internet mailing list, December 1999.

Land Rover stopped building the Series models in 1985. (See **Project vehicles**. See also **The best car in the world**.) The motor industry now produces 100,000 new vehicles a day worldwide. (See Car facts.)

But our critic had a point: the vehicles were green enough (even the blue one), but their fuel certainly wasn't. But we don't plan to pollute the atmosphere with dirty fossil-fuel exhaust fumes all the way from Hong Kong to Cape Town. There are better, cleaner, fuels -- and you can make them yourself!

Why make biofuels?

We had three aims in learning to make biodiesel and ethanol:

- Finding renewable fuels for our vehicles
- As an environmental project for schools participating in Journey to Forever
- As a means of improving energy self-reliance in rural communities.

Both biodiesel and ethanol are clean, grow-your-own fuels that can be made on-site in small villages from renewable, locally available resources, for the most part using simple equipment that a village blacksmith can make and maintain.

These fuels are among a wide range of sustainable rural energy

Food or fuel?
Straight vegetable oil as diesel fuel

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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Ethanol resources on the Web
Is ethanol energy-efficient?

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Trees, soil and water
Healthcare for mountains
Seeds of the world

options. Others are methane (biogas) digesters that turn livestock and crop wastes into cooking and heating gas, solar energy (see **Solar box cookers**), **wood gas**, charcoal and fuelwood (good fuels unless overharvesting destroys the trees themselves), wind power, water power.

Usually the "answer" is in a mix of technologies. Biofuels can be used to power small-scale farm and workshop machinery and electricity generators as well as local vehicles. Knowing how to make them provides a useful set of ecological questions in investigating local energy options which makes it more than worthwhile even if the final answer is "No".

For instance, should a crop such as peanuts be used to make fuel, or would the villagers be better off eating the peanuts? Or selling them? Or should they press them to make oil, for cooking or for selling, and feed the high-protein residue "cake" to livestock, which in turn they can either eat or sell, while using the livestock wastes (and the crop wastes) to make compost to renew the soil, or to generate biogas for cooking and heating? (The heat generated by the composting process can also be harnessed for heating.) Or should they grow a different crop altogether?

Should a grain crop be distilled to make ethanol fuel or should the villagers eat the grain? If they use the grain for livestock feed, it can be used for ethanol and *still feed the livestock*: the distillation process to produce ethanol converts the carbohydrates in the grain while leaving the protein. The protein residue is excellent stockfeed, which can be supplemented by forage crops which humans can't eat. This could mean improved utilization of the available resources.

This is the sort of question we'll have to find answers for in our work in rural villages. As always, it will be the villagers' views that decide the issue.

Foundation for Alternative Energy, Slovakia -- a good summary of the various ways to derive useful energy from biomass (34,000-word article):
http://www.seps.sk/zp/fond/dieret/biomass.html

Food or Fuel?

A common objection to biomass energy production is that it could divert agricultural production away from food crops in a hungry world -- even leading to mass starvation in the poor countries.

No seeds, no food
Appropriate technology
What works and fits
Project vehicles
The workhorses

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True or not? Not true: at best it's an oversimplification of a complex issue. It just doesn't work that way, and neither does hunger.

See: **Food or Fuel?**

Join the Biofuel mailing list

The **Biofuel mailing list** run by Journey to Forever is the biggest and fastest-growing alternative fuels mailing list. An information-sharing resource for the growing number of people all over the world who are making their own fuel or would like to. Ethanol and biodiesel. Get professional advice and share information. List URL:
http://groups.yahoo.com/group/biofuel

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The searchable message archives of the **Biofuel** and **Biofuels-biz** mailing lists are a treasure house of information on all aspects of biofuels, especially biodiesel, containing 35,000 messages over the last four years, many of them from leaders in the field worldwide. It's an independent archives provided and maintained by list member Martin Klingensmith, with powerful, fast and efficient searching, and no ads.
http://infoarchive.net/sgroup/biofuel/
http://infoarchive.net/sgroup/biofuels-biz/

Car facts

From **Grist Magazine**
http://www.gristmagazine.com/grist/counter/counter011900.stm

- 70 million motor vehicles were on the world's roads in 1950.
- 630 million motor vehicles were on the world's roads in 1994.
- 1 billion motor vehicles are expected to be on the world's roads by 2025, if the current growth rate continues.
- 50 million new cars roll off the assembly line each year --

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137,000 a day.

- 27 tons of waste are produced in the manufacture of the average new car.
- 11 million cars are junked annually in the US.
- 12,000 pounds of carbon dioxide are emitted by the average car each year.
- 5% of a car's fuel can be wasted by underinflated tires.
- 2 billion gallons of gasoline could be saved annually if 65 million car owners kept their tires properly inflated.
- 85% of auto fuel is consumed just to overcome inertia and start the wheels turning.
- 2.5 times more emissions are generated by SUVs (Sports Untility Vehicles) and light trucks than by standard cars.
- 33,000 natural gas vehicles were in use in the US in 1993.
- 75,000 natural gas vehicles were in use in the US in 1998.

-- by Josh Sevin
Sources: World Resources Institute; Environmental Working Group; 50 Simple Things You Can Do to Save the Earth; Amicus Journal; L.A. Times; U.S. Department of Transportation; Earth Communications Office; Amicus Journal; Wall Street Journal.

Facts & Stats On Cars, from the Recycling Council of Ontario -- learn just how earth-unfriendly cars really are, the complete horror-story: http://www.rco.on.ca/factsheet/fs_b02.html

(Auto Free Ottawa)

Visit the **Car Free Day** Web site by @Car Free Day Consortium:
http://www.ecoplan.org/carfreeday/cf_index.htm

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Solar Box Cookers

Half the inhabitants of Earth cook over woodfires. Nearly half the world's wood supply is used as fuel. But there's not enough of it to go round -- more than 2 billion people now face shortages of fuelwood.

Forests in the developing countries are shrinking by more than 15 million hectares a year. The critical forest-to-people ratio has never been lower -- worldwide, it is now less than half what it was in 1960.

The obvious answers are to plant more trees, and to stop people burning the trees that are left. But those in need do not have access to alternative fuels, and forestation schemes take years to produce their harvest -- if they work at all, which they often don't. In fact the schemes that work the best are those in which local communities are most involved and are the main beneficiaries. And the main local benefit is usually a sustained supply of firewood.

Smoke-filled rooms -- Midori and a Xhosa friend wait for dinner, cooking in a cast-iron pot over an open fire: Transkei, South Africa, 1997

-- "The best time to plant a tree was twenty years ago. The second best time is now." -- *Anonymous*

Meanwhile, deforestation leads to soil erosion, floods and climate change, severe environmental degradation, and increasing poverty and hunger.

The victims

The main victims of the fuelwood crisis are the women and children.

-- "The search for fuel consumes the time, energy and health of women and their children. As local wood supplies grow scarce, women risk spinal column damage and uterine prolapse from carrying heavier loads over longer distances. Girls are often kept home from school to help their mothers gather wood, depriving them of educational opportunities. Where wood is unavailable, women cook with inefficient fuels such as animal dung or crop wastes, depriving livestock of fodder and soils of natural fertilizer. This endangers both the nutritional and respiratory health of women and their families." -- *From "Forest Futures: Population, Consumption and Wood Resources" by Tom Gardner-Outlaw and Robert Engelman, Population Action International, 1999*

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http://www.populationaction.org/resources/factsheets/factsheet_10.htm

A solution

It's a complex problem, like all environmental problems. But there's one simple answer, that can save millions of trees, provide clean, safe drinking water, doesn't smoke, and costs very little -- solar box cookers, which can be made from cardboard cartons.

Midori cooking rice by solar power in Hong Kong

Research has found that 36% of the world's fuelwood needs (or 350 million tonnes of wood per year, according to UNICEF) could be replaced by solar box cookers, saving 500 kg of wood per family per year, equalling millions of trees.

-- "We are living and participating in a very strange system. Humanity has one foot stepping towards the stars, while the other is mired in a sinking sea of poverty. The distance between humanity's two feet is growing. We can help reverse the process by teaching several billion people in the Third World how to build and use solar box cookers." -- *From "Balancing the Scales" by Bill Sperber*
http://solarcooking.org/balance.htm

No fire, no smoke

Solar box cookers produce no smoke and no pollution: woodsmoke from cooking fires causes respiratory infections which kill at least 5 million young children each year.

Solar panel cookers in Ethiopia

-- "Women and children are most exposed to high levels of harmful smoke and suffer the most serious health damage ... studies in China found that smoke was a strong risk factor for lung cancer among non-smoking women ... in Gambia it was found that girls aged under five carried on their mother's back during cooking (in smoky cooking huts) had a six times higher risk of lung cancer -- a substantially higher risk factor than if their parents smoked." -- *From "Cooking smoke: a pervasive killer in developing countries" WIN News, 1 January 1998*
http://solarcooking.org/cookingsmoke.htm

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Indoor smoke pollution now ranks 8th in health burden worldwide (lost years of healthy life), and ranks fourth in the "least-developed" countries (which make up about 40% of the world population) according to the World Health Organization's **World Health Report 2002**.
http://www.who.int/whr/en

"**Smoke gets in their eyes**" -- Independent research indicates that indoor air pollution is a contributory cause of around two million deaths in developing countries. Acute respiratory infections, ear and eye problems, breathlessness, chest pains, headaches and giddiness are just some of the symptoms that poor woman and children suffer in their rural homes. And the cause? Smoke from cooking. ITDG -- Intermediate Technology Development Group:
http://www.itdg.org/html/whats_new/smoke_gets_in_their_eyes_pr.htm

Full report: "**Reducing indoor air pollution in rural households in Kenya: working with communities to find solutions**", ITDG project 1998-2001, January 2002. Acrobat file, 3.4Mb
http://www.itdg.org/html/advocacy/docs/smoke_project_report.pdf

Clean, safe water

The WHO says diseases spread through contaminated water cause 80% of the world's illnesses. Solar box cookers can pasteurize drinking water: heating water to 65 deg C for six minutes destroys disease organisms, and this temperature is easily achieved with solar box cookers.

-- "UNICEF estimates that 60% of rural families and 23% of urban families in developing countries are without safe water ... The most common recommendation is to boil the water. This recommendation is seldom followed [because of] the amount of scarce fuel it would require." -- *From "A summary of water pasteurization techniques" by Dale Andreatta*
http://solarcooking.org/solarwat.htm

Women's gain is everyone's gain

Solar box cookers would also save millions of women many hours (or days) wasted searching for firewood, giving them the time to look after their children, grow more food, and for education -- which is *the* key to reducing population growth.

-- "On the first day, the women walk to the nearest place where wood can be gathered. On the second day, they search for firewood. The third day is spent carrying the wood on their backs home to the village." -- *from Chad, Africa*

Solar box cookers can even be used on cloudy days.

Rural women in Nepal harness the sun in a basket

At least half a million solar box cookers are already in use, mostly in China and India, and projects are underway in most countries. UNICEF estimates the potential usage of solar box cookers at 200 million worldwide.

Solar box cookers are easy to make -- one cooker designed to be simple enough for 10-year-olds to build without tools in less than an hour is now helping to feed refugees in Africa.

Other solutions

Solar box cookers cannot replace firewood use, just supplement it. Other possible supplements for rural use are biofuels, biogas, wind and water power.

There is no feasible replacement for firewood in much of the world, nor is one required -- what is required is to balance growing demand with dwindling supplies.

Unlike fossil fuels, firewood is a renewable fuel, it's locally available, it supports local employment, and when properly burnt it doesn't contribute to the greenhouse effect -- the CO2 it releases is simply recycled.

But too often it isn't properly burnt: cooking fires are often inefficient, wasting energy, failing to combust the wood properly, contributing to greenhouse gas release and creating severe indoor smoke pollution.

Half the 3 billion people who use firewood don't have proper stoves or chimneys. Research and development efforts all over the world are working to remedy this problem.

More and better woodstoves mean less waste, more trees, better health and a better environment for all.

Second to firewood comes charcoal, which is an efficient, smokeless and clean fuel, but the charcoal production process is often inefficient and wasteful. Again, this is a focus of worthwhile development efforts in many countries.

At the root of all these problems, and of all development problems, is the grim spectre of poverty, now growing faster than ever before --

faster than the forests are shrinking, faster than the deserts are spreading -- and the cause of it is an unjust and inequitable economic system.*

Solar cooker resources on the web
Solar box cookers for schools

---

* At least 1 billion people go hungry in today's world.

The 1999 annual UN Human Development Report says the effects of globalization and increasing economic integration have led to the rich getting richer and the poor getting poorer in nearly every way.

UN statistics provide evidence of the widening gap between rich and poor:
-- In nine years, the income ratio between the top 20% and the bottom 20% has increased from 60:1 to 74:1.
-- Eighty countries have less revenue than they did a decade ago.
-- The assets of the world's 200 richest people exceed the combined income of 41% of the world's total population. (BBC World News, July 12, 1999)

The world's richest fifth consumes 86% of all goods and services while the poorest fifth consumes just 1.3%. (New York Times, 26 September, 1998, Week in Review)

Three billion people live on less than $2.00 a day. One billion people live on less than $1.00 a day. (World Bank)

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Trees, soil and water

The crops that feed the cities are raised in the valleys and flat river plains, but the fate of the valleys is decided in the hills and mountains where the streams rise.

Where the hillslopes and ridges in the upper reaches are covered with trees, the streams flow clearly and steadily and all is well in the valleys below.

Where the trees are gone, the soil washes down the slopes to clog the streams and foul the river bottoms, raising the water level, and when the rains come in the hills there is no soil left to hold the water -- flash floods sweep down into the valleys, rivers burst their banks, the floods ruin crops and lives, and wash yet more soil away to the sea. The water is wasted, the deserts spread.

Results of floods in 1930 at the mouth of the Parrish Canyon in Utah. Compare damage from protected and unprotected canyons. (Jacks and Whyte)

So the Journey to Forever route is a steep and mountainous one, moving ever upstream to seek out isolated hill-farming communities, focusing on water management, and on tree-based cropping systems.

Multi-purpose groves of mixed trees can maintain the soil for other crops and provide large yields of fruit and nuts, forage and fodder for a variety of livestock, timber and fuel, and a host of other products -- and clean, steady water for the valleys below.

Water wars

The soil is a nation's real capital, and water, not oil, is the truly valuable resource. A future war over water is a real possibility, according to Klaus Toepfer, Director-General of the United Nations Environment Program (UNEP) and former minister of the environment for Germany. He said he is "completely convinced" there will be a war over water (Environmental Science & Technology journal, January 1, 1999).

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At the international conference on Water and Sustainable Development hosted by the French government at UNESCO headquarters last spring, French President Jacques Chirac also warned of future water wars. UNESCO Director-General Federico Mayor and Chirac warned that, without international co-operation, dwindling water resources could threaten development and world peace.

"More than petrol or land, it is over water that the most bitter conflicts of the near future may be fought," Mayor said.

"The wars of the next century will be about water," warned Ismail Serageldin, World Bank Vice President and Chairman of the Global Water Partnership, in 1995, and again in 1999: "Severe conflicts due to competing claims for water may erupt from what are increasingly rancorous disputes over water."

No trees, no soil, no water -- desert

"Destruction of the earth's thin living cover is proceeding at a rate and on a scale unparalleled in history, and when that thin cover -- the soil -- is gone, the fertile regions where it formerly lay will be uninhabitable deserts." That could have been written yesterday, but in fact it's more than 60 years old -- from The Rape of the Earth: A World Survey of Soil Erosion, by Jacks and Whyte, published in 1939.

Burnt-over forest in Southern Rhodesia (Zimbabwe) in 1930. (Jacks and Whyte)

Our hill farm when we arrived: trees cut down, terraces broken, all the soil washed away.

Today, the deserts are spreading at the rate of five million hectares a year worldwide (not yet quite as fast as the forests are vanishing). A third of the world's land surface is at risk from desertification, threatening the livelihoods of more than 850 million people (United Nations Development

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Program).

American researcher J. Russell Smith charted how this disastrous progression could be reversed by using special trees, especially in the hills. "When we develop an agriculture that fits the land, it will become an almost endless vista of green, crop-yielding trees," he wrote in **Tree Crops: A Permanent Agriculture** (1929).

-- "Agriculture in mountainous, rocky or dry regions is a disaster, but trees are salvation," wrote Fritz Schumacher, author of "Small is Beautiful: Economics As If People Mattered" and founder of the Intermediate Technology Development Group.

But forestry projects often don't work very well, especially when they're centrally planned. One project achieved only 2.5% of the production claimed. (See Ipil-ipil, the 'magic tree'.)

And "re-forestation" often replaces a mature forest rich in biodiversity with a biologically simple plantation.

It can be a different matter when projects are mounted at the local level -- forestry as if people mattered. There are many such projects, quietly planting trees where there

Nothing grew in the exposed subsoil except a few sprigs of pest grass.

Eight months later it was bursting with crops.

Five years after we left -- lawns, shrubs, and fruit from the trees we'd planted.

Village crops wrecked, beds ruined and soil washed away in a tropical storm.

were none, bringing multiple benefits to the local people who plant them and tend them, and to everybody else too, though you don't hear much about it.

The same storm did no damage to our no-dig beds -- no soil lost.

Trees, soil and water

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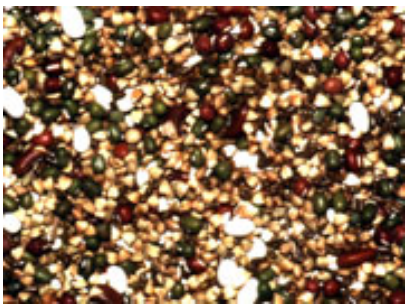
Seeds of the world

"The earth was not given to us by our parents, it was loaned to us by our children." -- Kenyan proverb

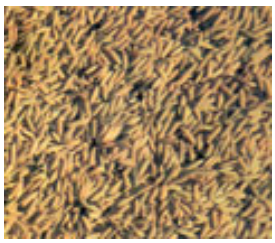
Traditional varieties of vegetables and grains are a vital heritage: they could be the key to our food security in the future. But, where hundreds of varieties of a crop were once grown, now there may be only two or three, or the crop itself may have been abandoned.

Plant Patenting Laws have made seeds big business, largely controlled by a handful of big companies. (The top 10 seed companies control about 33% of the US$24.4 billion global seed trade, with the top three companies controlling 20%.) Varieties that do not have a world market lose their place and may no longer be sold. Soon they vanish, forever.



Yet the lack of genetic diversity in food crops greatly increases their vulnerability to pests and disease -- while breeding new resistant varieties requires the germ-plasm of the old varieties which are being lost.

And at a time when the global climate is changing in unpredictable ways, nobody knows what sort of crops may be needed in the future -- the meagre number of commercial varieties available could prove useless in the new conditions.



Green Revolution high-yielding hybrid rice

The brave new seeds of the "Green Revolution" are hybrids -- so-called HYVs, high-yielding varieties that will not breed true and must be bought anew from the seed companies each year.

Others have renamed them HRVs -- high-response varieties, increasingly bred to respond to high levels of chemical fertilizers and for resistance to toxic pesticides. Seldom are the high yields reported in the test fields reproduced on actual farms, less still on the small farms most Third World people depend on for their food supply. And the new seeds lack the nutritional content of the traditional varieties.

High-yelding hybrid corn -- about as nutritious as tissue paper

Other tests have shown that old varieties, grown with good soil management and NO chemicals, can equal the yields of the hybrids and far surpass their nutritional quality.

And, unlike the traditional varieties, the new hybrids do not last long -- even with high levels of chemical protection, they succumb to pest attack after a few years and have to be replaced by another newly bred hybrid.

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And here lies the problem: the germplasm for the new seeds comes from the old varieties, but the new seeds displace the old -- often where once scores or hundreds of old varieties were grown, now there's only one, the same new variety that now needs replacing.

As one expert commented, it's a strange technology that destroys the very foundation it depends on.

The development of GE (Genetically Engineered) seeds (also termed GMOs -- Genetically Modified Organisms) that contain genes from quite different plants -- or from life-forms that are not plants at all -- has now taken the erosion of sustainable crop varieties to a whole new level of risk.

In collaboration with food crop conservation organizations, Journey to Forever will collect seeds of useful local varieties of food crops wherever we go, saving them for the future as well as redistributing them to other farmers further along our route. We will work with concerned NGOs to ensure that peasant plant breeders' rights are protected.

See: **Seed patents threaten world food resources**

Seed resources

RAFI -- Vanishing seeds: "Loss of genetic diversity in agriculture -- silent, rapid, inexorable -- is leading us to a rendezvous with extinction -- to the doorstep of hunger on a scale we refuse to imagine" -- Cary Fowler and Pat Mooney, "The Threatened Gene" (1991). Pat Mooney is executive director of the Rural Advancement Foundation International (RAFI).
http://www.rafi.org/

"More than 90 per cent of crop varieties have disappeared from farmers' fields." -- **UK Agricultural Biodiversity Coalition**
http://www.ukabc.org/
This site has good resources on seed issues and food security.

"One of the world's most pervasive threats to world food and livelihood security is the loss of biological diversity." -- **Genetic Resources Action International (GRAIN)**
http://www.grain.org/

GRAIN is an international NGO, part of a global movement of popular action against genetic erosion. Publishes the excellent "Seedling" newsletter, books and other materials, briefings and ad hoc publications, global trade and biodiversity in conflict, an email mailing list. Site search. Website also in French and Spanish versions.

"In order to have access to a wide diversity of useful plants to meet our essential needs beyond 2000, we must gather, annotate, and caretake

these resources now, before they are further eroded." -- **Seed Savers' Network**
http://www.seedsavers.net/index.html
This Australian seedsaving group is involved in projects in Zimbabwe, Cambodia, Tonga, Cuba and the Solomon Islands.

A trainee of the Community Seed Bank Training Program in the Solomon Islands collects long red beans from a subsistence garden (Seed Savers' Network)

The widespread loss of plant diversity is eroding the foundations of agricultural productivity and threatens other plant-based products used by billions of people worldwide, according to a study by the **Worldwatch Institute**. Environmental News Network report:
http://enn.com/news/enn-stories/1999/09/092199/preport_5708.asp
Worldwatch Institute News Release "Plant Losses Threaten Future Food Supplies and Health Care":
http://www.worldwatch.org/alerts/990916.html

The **Heritage Seed Library** run by the HDRA in Britain aims to conserve as much biodiversity as it can and make as many varieties of vegetables available as possible. About 700 varieties in the collection, mostly vegetables. Seeds are supplied to volunteer Seed Guardians who cultivate threatened varieties of vegetables in their gardens. A Seed Swap section encourages informal exchange of rare seeds. The Library also publishes the quarterly newsletter Seed News covering plant genetic resources.
http://www.hdra.org.uk/hsl/index.htm

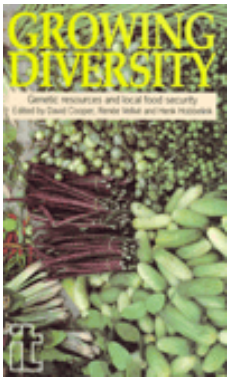
Read **Future Foods**' catalogue for a picture of what seed saving can mean -- a wonderful list of plants and trees, many rare and old varieties from around the world, plants of obvious value.
http://www.futurefoods.com/

SeedSaving Resources -- This comprehensive site is a "one-stop-shop" of Web resources on plant genetic resources, seedsaving and seed swapping, and worldwide sources of organic, heirloom, open-pollinated and non-GE seed and plants.
http://homepage.tinet.ie/~merlyn/seedsaving.html

The **Seed Exchange** email list has nearly 700 members from around the world, including university agriculture departments and research stations. Moderated list, no advertising, members' email information kept totally private. To subscribe send a blank email to: seeds@nowonline.net with the word SUBSCRIBE as the subject of the message.

Native Seeds/SEARCH (NS/S) of Tucson, Arizona, is a nonprofit organization that works to conserve the traditional crops, seeds, and farming methods that have sustained native peoples throughout the

southwestern US and northern Mexico. "We promote the use of these ancient crops and their wild relatives by gathering, safeguarding, and distributing their seeds, while sharing benefits with traditional communities. We also work to preserve knowledge about their uses. Through research, training, and community education, NS/S works to protect biodiversity and to celebrate cultural diversity. Both are essential in our efforts to restore the earth."
http://nativeseeds.org/



"Growing Diversity: Genetic Resources and Local Food Security", by David Cooper, Renée Vellvé, Henk Hobbelink (editors), 1992, IT Publications, ISBN 1-85339-119-0
Edited by GRAIN (Genetic Resources Action International), this book presents the experiences of NGOs in managing genetic resources at the local level in the Third World. Fifteen authors document the work of local farmers in developing crop varieties suited to their needs and demonstrate how these approaches can be built upon to promote conservation and development. From Stylus Publishing:
http://www.styluspub.com/books/book2288.html

"Saving the Seed: Genetic diversity and European agriculture", by Renée Vellvé, GRAIN, 1992, Earthscan, ISBN 1-85383-150-6
"Pandas are cute, tropical rainforests are breath-taking, but how do you mobilize people to save a carrot?" Traces the decline of crop varieties in European farming, and describes what is being done to safeguard genetic resources for the future. The crucial work is being done by individuals and grassroots organizations, who largely go unrecognized and under-resourced. Policies to promote the diversification of European agriculture and an integrated strategy for safeguarding the genetic base of the food system are urgently needed. From Earthscan Publications:
http://www.earthscan.co.uk/asp/bookdetails.asp?key=1871

First chapter of "Saving the Seed", **"The making of a heritage"**, full text online at GRAIN:
http://www.grain.org/publications/creation-document-rv-heritage.cfm

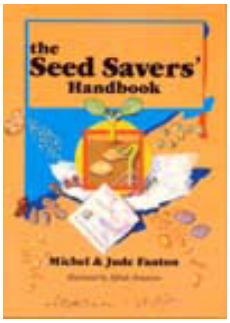
German version, **"Lebendige Vielfalt"**: available from ABL, Marienfelder Strasse 14 33378 Rheda-Wiedenbrück Germany.

"Lost Crops of Africa: Volume I: Grains" by Noel Vietmeyer, 1996, National Academy Press, ISBN 0309049903
Africa has more native cereals than any other continent. It has its own species of rice, as well as finger millet, fonio, pearl millet, sorghum, tef, guinea millet, and several dozen wild cereals whose grains are eaten from time to time. This is a food

heritage that has fed people for generation after generation stretching back to the origins of mankind. It is also a local upon which a sound food future might be built. But this legacy of genetic wealth has largely been bypassed in modern times. The "lost crops" can help provide food security in their native areas, which include many parts of Africa threatened with hunger. At the same time maintaining the diversity of these ancient crops will protect options for the rest of the world to use. Full text online at the National Academy Press:
http://www.nap.edu/books/0309049903/html/
From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/LostCropsAfrica.html

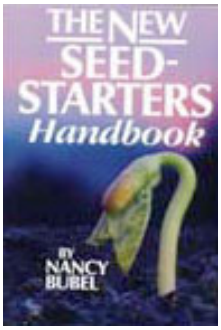
Ethiopia's Living Laboratory of Biodiversity -- In Ethiopia, home of one of the most publicized famines in the mid-1980s, farmers play a pivotal role in preserving and enhancing some of the world's most unique seed genetic material. Amid Ethiopia's diverse topography, climate and soil conditions, local farmers have developed a tremendous base of food-producing seeds. In an effort to ensure Ethiopia's seed genetic diversity, scientists are discovering that farmers are not merely an adjunct to conserving and enhancing this diversity but are key actors.
http://www.idrc.ca/books/reports/12ethiop.html

"Lost Crops of the Incas: Little-Known Plants of the Andes with Promise for Worldwide Cultivation" Board on Science and Technology for International Development, National Research Council, 1989, ISBN 0-309-04264-X.
Detailed information on more than 30 different Incan crops that promise to follow the potato's lead and become important contributors to the world's food supply. Some of these overlooked foods offer special advantages for developing nations, such as high nutritional quality and excellent yields. Color photographs of many of the crops plus the authors' experiences in growing, tasting, and preparing them in different ways. Full text online at the National Academic Press:
http://www.nap.edu/catalog/1398.html



"Seed Savers' Handbook" by Michel & Jude Fanton, 1993
Without dedicated seed savers, our staple foods would not exist. Such seed resources are only safe in the hands of people who save and grow them and eat their bounty; they are lost in "collections" or storage, or in hybrids wholly owned by multinationals. The Fantons, founders of Australia's SeedSaver's Network, show how gardeners can protect our global food heritage -- and eat it too. They describe the seed collecting, growth cycles, propagation, cultivation and traditional kitchen and medicinal uses of over one hundred vegetables, culinary herbs and edible flowers. "This book will be of immense use to all of us who grow or want to grow good food in our gardens and on our farms. I believe this book to be essential for all caring gardeners, farmers, cooks and parents and I trust that it will speed our return to good nutrition and a healthy society." -- Bill Mollison (The

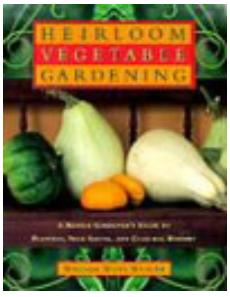
Permaculture Institute). From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/SeedSaversHandbook.html



"New Seed-Starters Handbook" by Nancy Bubel, 1988, Rodale Press, ISBN 0-87857-752-1
Turn to this book for the most complete, up-to-date information on starting plants from seed. Written by a gardener with 30 years of experience, this easy-to-use reference explains everything you need to know to start seeds and raise healthy seedlings successfully. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/SeedStarterHandbook.html

More good resources on seeds and seed saving from ECHO:
http://echonet.org/shopsite_sc/store/html/Seedsaving.html

"Farmers' Seed Production: New approaches and practices" edited by Conny Almekinders, Niels Louwaars, 1999, ITDG Publishing, ISBN 1853394661
This handbook covers a whole range of issues relating to local seed supply systems, including participatory plant breeding, and both technical and practical information on seed production and variety maintenance. It suggests new approaches and methods to support on-farm seed production by small-scale farmers in developing countries. From Intermediate Technology Development Bookshop:
http://www.developmentbookshop.com/book.phtml?isbn=1853394661
From Stylus Publishing:
http://www.styluspub.com/books/book4292.html



"Heirloom Vegetable Gardening -- A Master Gardener's Guide to Planting, Seed Saving, and Cultural History" by William Woys Weaver, 1997, Henry Holt & Company, ISBN 0805040250
Lists 280 varieties of vegetables, all organically grown by Weaver. He has researched the traditional kitchen garden over the course of 30 years. Old fashioned recipes, research on the introduction of these vegetables, color photographs and line drawings. Weaver maintains his own collection of over 2,000 varieties of vegetables, herbs and flowers. From Powell's Books
http://www.powells.com/cgi-bin/biblio?inkey=6-0805040250-3

Genetically Engineered crops

"Biotech has bamboozled us all -- Studies suggest that traditional farming methods are still the best" Guardian, August 24, 2000: "If anyone tells you that GM is going to feed the world," Steve Smith, a director of the world's biggest biotechnology company, Novartis, insisted, "tell them that it is not... To feed the world takes political and financial will -- it's not about production and

distribution." Mr Smith was voicing a truth which most biotechnology companies have gone to great lengths to deny.
http://www.guardian.co.uk/Archive/Article/0,4273,4054683,00.html

"Ten reasons why biotechnology will not ensure food security, protect the environment and reduce poverty in the developing world" -- by Miguel A. Altieri, University of California, Berkeley and Peter Rosset, Food First/Institute for Food and Development Policy
http://www.foodfirst.org/progs/global/biotech/altieri-11-99.html

"Will Biotechnology Feed the World's Poor?" -- "One of the biggest myths perpetuated by the biotechnology industry is that genetically engineered crops are likely to provide a solution to world hunger" -- Tom Campbell, Development Studies Centre, Kimmage Manor, Dublin, Ireland
http://www.pmac.net/campbell.htm

"**Genetic Engineering and World Hunger**: Food? Health? Hope?" -- "Ensuring food security worldwide requires an approach that is the opposite of that promoted by Biotechnology companies". 16,000-word article from Britain's The CornerHouse, debunks the GE companies' claims that genetic engineering is the key to feeding the world's increasing numbers of people, that it will help to restore a healthy environment and prevent further degradation, and that it will provide farmers and consumers worldwide with more choices and opportunities.
http://www.ukabc.org/ge_wfs.html

The **Rural Advancement Foundation International (RAFI)** is at the forefront of the battle against GE crops and biopiracy
http://www.rafi.org/

On **biopiracy**, read RAFI's report **"Plant Breeders Wrongs -- The Biopiracy and Plant Patent Scandal of the Century"**: "'Plant patent' offices in several industrialized countries are knowingly granting plant variety monopolies to plant breeders for cultivars actually bred by farmers in at least 43 Third World countries." Lists 147 "dubious" plant variety claims.
http://64.4.69.14/web/allnews-one.shtml?dfl=allnews.db&tfl=allnews-one-frag.ptml&operation=display&ro1=recNo&rf1=16&rt1=16&usebrs=true

The Captain Hook Awards -- For Outstanding Achievements in Biopiracy:
http://64.4.69.14/web/allnews-one.shtml?dfl=allnews.db&tfl=allnews-one-frag.ptml&operation=display&ro1=recNo&rf1=104&rt1=104&usebrs=true

"GMOs are without a doubt the least democratic and most unpopular new technology since nuclear energy, and their potential to catalyze global ecological and social disaster is terrifying." -- **Friends of the Earth International**

http://www.foei.org/

"No Genetic Manipulation of Nature!" -- **Greenpeace**
http://www.greenpeace.org/~geneng/index.html

Excellent biotechnology resources at the **Institute of Science in Society** website, with reports by Dr. Mae-Wan Ho, Angela Ryan, Prof. Joe Cummins, and others. Newsletters, mailing list, full site search.
http://www.i-sis.org/

The Research Foundation for Science, Technology and Ecology was founded in India in 1982 by **Dr. Vandana Shiva**, scientist, author and a leading opponent of GE crops and biopiracy.
http://www.vshiva.net/

Dr Vandana Shiva

UK Agricultural Biodiversity Coalition
http://dspace.dial.pipex.com/ukfg/ukabc.htm

Genetic Resources Action International (GRAIN)
http://www.grain.org/

Biotechnology and Biosafety -- a large collection of reports, articles, publications from the **Third World Network**
http://www.twnside.org.sg/bio.htm

Open Letter from World Scientists to All Governments: "We, the undersigned scientists, call for the immediate suspension of all environmental releases of Genetically Modified crops and products; for patents on life-forms and living processes to be revoked and banned; and for a comprehensive public enquiry into the future of agriculture and food security for all."
http://www.i-sis.org/list.shtml#letter

"Genetically Engineered food -- Safety Problems" -- Physicians and Scientists Against Genetically Engineered Food is demanding a moratorium on GE food.
http://www.psrast.org/indexeng.htm

The **Union of Concerned Scientists** "asks hard questions about the risks and benefits and whether other alternatives would accomplish the same purpose [and] whether each product will move agriculture toward sustainability or whether it might block progress in that direction".
http://www.ucsusa.org/agriculture/index.html

The Campaign to Label Genetically Engineered Foods -- Campaigns, Action Alerts, information, resources, online bookstore and more:
http://www.thecampaign.org/

Against the Grain: Why poor nations would lose in a biotech war on hunger -- The promise [of biotechnology] of more abundant and more nutritious food appears to hold out the hope that hunger and disease can be alleviated. With potential like this, who wouldn't be in favor of genetically engineered crops? For starters, many of the people they are supposed to help. -- Sierra Club
http://www.sierraclub.org/sierra/200107/profile.asp

"World food 'under threat'" -- Environmental groups said patenting by multinational corporations threatens food security and access by farmers to vital genetic resources. And they argued US efforts to block a new worldwide treaty on plant genetics would be every bit as damaging to life on Earth as Washington's refusal to implement the Kyoto Protocol on climate change. -- BBC News, 25 June, 2001
http://news.bbc.co.uk/hi/english/sci/tech/newsid_1407000/1407301.stm

The Green Revolution

"**The Violence of the Green Revolution** -- Third World Agriculture, Ecology and Politics", by Vandana Shiva, Zed Books, London, and Third World Network, Malaysia; ISBN; 983-99573-8-4 (Hb.) 983-99573-9-2 (Pb.) 264 pages, 14-21.5cm Hardcover: US$23.00 paperback: US$15.00
Dr. Shiva examines the impact of the Green Revolution on the breadbasket of India, showing how the "quick fix" promise of large gains in output pushed aside serious pursuit of an alternative agricultural strategy. She documents the destruction of genetic diversity and soil fertility that resulted.
http://www.twnside.org.sg/title/vio-cn.htm

"**World Hunger: Twelve Myths**", 2nd ed., by Frances Moore Lappé, Joseph Collins, Peter Rosset with Luis Esparza, Food First/The Institute for Food and Development Policy, 1998, 270pp, $13.00. First published in the early 1970s, the World Hunger report is an authoritative resource on the problem of global hunger -- highly recommended. It debunks 12 persistent misconceptions about hunger, including Myth 5: "The Green Revolution is the answer." Thorough examination of the issue. The book isn't just a damnation of wrong-headed development efforts, it also offers a well-considered way forward.
https://www.foodfirst.org/merchant2/merchant.mv?Screen=PROD&Store_Code=FFB&Product_Code=0-8021-3591-9&Category_Code=OTHER

"Lessons from the Green Revolution -- Do We Need New Technology to End Hunger?" Peter Rosset, Joseph Collins, and Frances Moore Lappé, Tikkun Magazine, March/April 2000
http://www.foodfirst.org/media/opeds/2000/4-greenrev.html

"**Nutrient starved soils lead to nutrient starved people**", by Keith Addison, cover story, acres, USA, June 1983, also cover story, Asian Business, February 1983: "Many are the rice terraces hewn with

incredible labour from upland slopes and tragically abandoned after only a year when the ground failed to yield a crop at all -- meaning the end for that family. Had they used native rice, they would have got some crop at least. But hybrid seeds are now virtually the only seeds available and they will not grow without the expensive inputs that these people have no access to."

"**Treasure in a bowl of porridge**" -- Tai Long Wan: Tales from a vanishing village, by Keith Addison. A development project in the Philippines reports a setback to their plans to grow 20 hectares of traditional strains of rice to help small farmers survive the onslaught of the Green Revolution -- they could only find two kilos of native seed in the entire province. Background on the Green Revolution and the seeds crisis.

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Appropriate technology

Appropriate technology resources
Agriculture resources
Wood resources
Blacksmithing
Wood fires that fit
Houses that fit
Water-powered water pumps
Journey to Forever and AT
Chinese watering cans (with plans)
Hoe for victory!
Billhooks and sickles
A better rat trap
Rats and owls
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Bucket rat trap
Appropriate technology subjects

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Appropriate technology

Apt: suitable for the circumstance or purpose, appropriate, fitting, adapted to, having a tendency to behave as specified.

Sustainable: capable of being maintained at a steady level without exhausting natural resources or causing severe ecological damage -- Forever!

Small: Appropriate technology stemmed from the work of the British economist Dr. Fritz Schumacher, author of the book "Small is Beautiful -- Economics as if people mattered", which is still the foundation text on a sustainable future. Appropriate technology is the kind of technology that fits small-scale, grassroots, people-centred economics.

Dr. E.F. Schumacher

But small is powerless, we're used to thinking. Well, atoms are small. So are viruses.

"If you think you are too small to make a difference, try sleeping with a mosquito." -- *the Dalai Lama*

Can a small NGO match a huge multinational oil company when it comes to reducing greenhouse gas emissions? Dr. W.S. Hulscher, Chief Technical Adviser for the Regional Wood Energy Development Program in Asia (RWEDP), compared the effects of a small, local NGO distributing improved wood and charcoal stoves to villagers in Laos with the potential of a large production facility for photovoltaic solar energy panels built by Shell in Europe -- with surprising results: they're equal. "Solar electricity is 1,000 times more expensive than cooking on wood," he adds. See "The Battle in the Greenhouse": http://www.rwedp.org/p_ngoshell.html

Ask the Monsanto Corporation whether they think small NGOs are powerless. (See **The Internet**.)

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Here's a good description of appropriate technology:

"Appropriate technology is being mindful of what we're doing and aware of the consequences. Appropriate technology works from the bottom up; it is not an overlay to the situation; it is a genuine grassroots solution to economic needs.

"In the Industrial World small businesses account for more technological advances in their areas of expertise than government supported researchers or research departments in massive corporations. Third World craftspeople, farmers and other villagers invent, create, and contribute to the technological process of their area much more than outside 'experts' do.

"The definition of 'Appropriate Technology' changes with each situation... One quality that remains the same, however, is taking care of things. In each situation, the essence of AT remains appreciating, helping, caring. Planned obsolescence, throw-away products, poor quality all go against intelligent decision-making and the true spirit of appropriate technology." -- From "What is Appropriate Technology?" by Steve Troy of The Sustainable Village.

It "changes with each situation" -- as it must in a natural world where people matter. Mother Nature never heard of "standardization" -- that's a concept from an economic world where people don't matter, except as "consumers". Real life is infinite variety, which appropriate technology has to fit, rather than forcing life to fit the technology.

Appropriate technology is technology that fits.

It's a very broad-ranging subject -- a philosophy as much as a technology, a way of seeing things. But some aspects of it are definite and clear-cut: for instance, waste is not appropriate. We "Reduce, Reuse, Recycle", but we're still very bad at it -- about the only thing modern industrial society is good at recycling is gold, which is pretty useless stuff anyway. (You can make quite a powerful explosive out of gold, but it's not widely used, for some reason.)

We're going to have to learn to recycle everything as well as we recycle gold.

We're also going to have to clean up the mess we've made -- and any technology that helps us do that will definitely be appropriate.

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Handmade Projects
Ichijima
Japan

Some resources on appropriate technology and a focus on several specific areas follow in subsequent pages, along with some of Journey to Forever's appropriate technology work -- with high-powered Chinese watering cans, hoes, billhooks, stoves.

In fact appropriate technology is to be found throughout this website, and the whole Journey to Forever project.

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The workhorses

Handmade Projects has two 4-wheel-drive Series III Land Rovers. They can go more or less anywhere, they're tough, very capable and built to last.

Originally developed as utility vehicles for farmers, Land Rovers can power a wide variety of tools and implements -- tillers, seeders, sawmills, winches, pumps, power generators, compressors, welders, or a full blacksmith's workshop. They can carry a heavy load and can pull almost anything -- very useful things to take into a remote rural village.

But they have no air-conditioners, no computers, no chips or transistors, no power steering, no soft suspension, no upholstered seats, and no concessions to comfort or style -- only to function. And when they break, you can fix them.

They date from the Mechanical Age before computers, made with tried and trusted technology developed through many decades of use, built to work and to last. One of our Land Rovers is 22 years old, the other is 27, but that's nothing in the life of a Land Rover.

It's been said that 70 per cent of all Series Land Rovers ever built are still running, and the first one was built 52 years ago. Rover stopped building them in 1985.

The project vehicles

1973 Land Rover Series III 4x4 Military Lightweight (Air-Transportable) 88" SWB 2.25-litre petrol softtop, acquired June 1996, licensed, in running order.

1978 Land Rover Series III 4x4 109" LWB 2.25-litre diesel three-door hardtop, acquired August 1998, licensed, in running order.

Both these classic vehicles were rescued from disuse and eventual ruin, standing idle beside old paddyfields on Lantau Island in Hong

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Kong.

Repairing the damage caused by neglect and decay, restoring the two vehicles to working condition and getting them through the government road test has taken a great deal of time and effort, but we've learnt a lot in the process, and built up a useful database of off-road and general automotive information and resources.

Rescuing the Lightweight from the paddy field

The vehicles have also cost a lot of money, in acquiring them, on parts and repairs, licensing, insurance, and in equipping the project's workshop.

While we've brought the two Land Rovers back from the grave and got them working properly, preparing and equipping them for such a long journey and for the work they'll be doing en route requires professional support, both in preparation and during the journey.

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The Internet

It's new, it's different, and it's going to change just about everything. It's an amazing new Post Office. It's the biggest and best library there's ever been. It's the education of the future. It means hope, and empowerment.

But what exactly is the Internet?

Hardware, is the short answer. The Internet consists of a few hundred thousand server computers and the telecommunications networks that connect them, using a technology called "packet-switching" that breaks up digital messages into bits, sends the bits via the most easily available routes and reassembles them at the other end.

This is why it's not instant like a telephone, and also why it's so much cheaper than using a telephone. No packet-switching, no Internet. It's a distributed, decentralized network -- nobody owns it and nobody can control it.

But what most people mean when they talk of the Internet is the software. Four main kinds: email, Usenet newsgroup message boards, real-time chat, and the World Wide Web, which is steadily gobbling up the other three. It's the Web more than anything else that's behind the fantastic growth of the Internet in the last eight years.

Why does it matter?

The Internet is still in its infancy. Let's spell it out: it's a little baby compared to what it will grow into.

But already it's changing the way people work, shop, interact with each other, with society, and with the environment. Ordering something from a website and having it sent overnight uses much less energy than driving to the supermarket and back. For companies, building a website is a whole lot cheaper than building a retail outlet.

The US EPA recently calculated that energy savings from reduced construction alone arising from the growth of e-commerce could mean savings of 300 million metric tons of CO2 emissions by 2010.

A recent US energy study found that, for the first time ever, energy use was falling well behind economic growth, and attributed it largely to Internet use. Previously, growth has always meant more energy and more pollution.

E-commerce also saves paper -- one study predicted savings of almost

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3 million tons of paper a year by 2003, saving trees, energy, and 10 million tons of CO2 emissions a year.

The leveller

A corporation's website may not be any more effective than a teenager's -- in fact the teenager might have a better grasp of web essentials than the corporation's advertising agency has. Web surfers generally don't like hype and simply walk away from a hard-sell. Corporate slick often fails to impress.

In 1999 the mighty Monsanto chemical corporation suffered severe damage when it was forced to abandon its highly dangerous Terminator GM seed technology, mainly as a result of concerted opposition by a tiny NGO called RAFI (Rural Advancement Foundation International), five people with computers.

Networking and the speed with which new information can be distributed via the Internet has brought new meaning to social campaigns.

Healthy trends

The Internet is changing the way we think. It's the first medium that isn't passive: Internet users are far more assertive than TV viewers, and it becomes a habit. Less and less do Internet users fit the cosy idea of communities as mere "markets" of passive consumers.

As everywhere else, sharks and predators prowl the murkier depths of cyberspace, sleaze seeps through the seams, and it tends to obscure the many healthy trends.

Communication is healthy -- it breaks down barriers, and with the Internet more people are communicating more than ever before: 750,000 messages a day are posted on the Usenet newsgroups alone, and email and chatlines account for much more than that.

The level of cooperation, the kindness and generosity Internet groups show to newcomers and each other, the immense trouble people -- many people -- will go to, without pay or reward, to make better resources available and to help people they don't even know, all expose the "marketplace" and the idea that people are only motivated by greed and self-interest as the sheer nonsense it always was.

And the levels of maturity, fairness and responsibility so many Internet groups demonstrate in their self-administration and general conduct is a strong counter to the idea that communities need nannying authorities to tell them what to do.

Most significant factor: children love the Internet. So do schools.

The Information Gap

The Internet gap is even wider than the wealth-poverty gap. Only about 10% of the world's people are connected -- two billion people on the planet have never even used a telephone. And the gap is growing.

These are serious issues: the poor, the deprived, and especially the Third World are being left behind in altogether new ways which could prove critical. See "Bridging the digital divide" (BBC): http://news.bbc.co.uk/hi/english/special_report/1999/10/99/information_rich_information_poor/newsid_466000/466651.stm

Here is an "educated guess" as to how many were online worldwide as of September 2002. It's grown by nearly 50% in only two years.

Africa 6.31 million
Asia/Pacific 187.24 million
Europe 190.91 million
Middle East 5.12 million
Canada & USA 182.67 million
Latin America 33.35 million
World Total 605.60 million

Compiled by Nua Internet Surveys
http://www.nua.com/surveys/how_many_online/

Africa's total has more than doubled, and its share has grown slightly, but it's still only just above 1%. Same in the Middle East -- more than doubled, but less than 1%, while Latin America's share has grown from 4% to 5.5%. In the Asia/Pacific region, a mixture of rich and poor countries, the total has grown by 79% and the share from 26% to 30%, now more than the US and Canada, where the total grew by only 9%. Europe's share has grown by 77% and has also passed the US and Canada, from only 67% of the US-Canada total in 2000. Europe now rates #1, Asia/Pacific #2 and US/Canada #3.

Growth in the poorer regions has been phenomenal, but their overall share has increased only slightly, or not at all -- the digital gap remains.

The statistics show that most Internet users are young, white, rich, Western, and male. But statistics are both revealing and deceptive, perhaps nowhere more so than with the Internet.

For instance, of the 10 most common search terms used by web surfers in 1999, most popular was "sex". Seven of the 10 were searches for

entertainment. Get the picture? -- young, white, rich, and male.

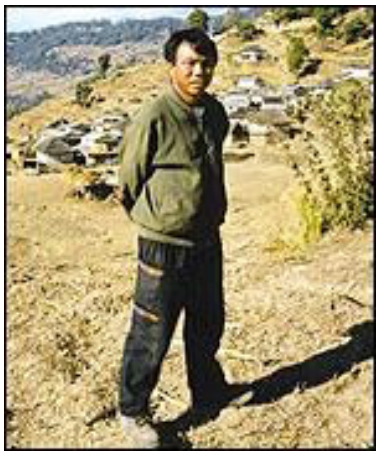
However, what this picture doesn't show is that the 4th most popular search was for the World Wildlife Fund and No. 9 was Poetry, and that's much more significant.

The same applies to how people are using the Internet. Despite the growing gap, computers and the Internet are bringing new capabilities and effectiveness to the groups and individuals fighting poverty, hunger, environmental degradation, exploitation and injustice on every front.

It changes the picture. It doesn't make the digital gap any less severe, but in one sense all that means is that people who didn't have something before it existed still don't have it, which doesn't change their situation.

"Our priorities are hygiene, sanitation, safe drinking water," said a health worker in Nepal. "How is having access to the Internet going to change that?"

In fact, others who do have Internet access are using it for exactly these purposes: to improve hygiene, sanitation and drinking water in the Third World. You can find links to some of them elsewhere in this website. Maybe you can help them.



Village in the clouds embraces computers -- Mahabir Pun is trying to break the cycle of poverty in his mountain village of Nangi in Nepal by taking it into the computer age. Having founded Himanchal High School, he sees the internet as the way to improve education. "If we walk about six or seven hours outward in any direction from our village and ask the people there where Nangi is, most of the people will have no idea. With the simple website we have now, people from around the world have been able to locate my village and have come to volunteer. We regularly get volunteers from America, Britain, Australia, Singapore, Switzerland and Malaysia. Moreover, students from Australia and America have been writing letters to our pupils as penpals through ordinary mail. As far as I know this is the only community school in the entire country that provides computer classes for high school students."
http://news.bbc.co.uk/1/hi/sci/tech/1606580.stm

The E-Marketers of South India -- In addition to improving the living conditions of the e-marketers, India Shop generates money for

the artisans who work in hundreds of villages surrounding Chennai by promoting their products. This keeps centuries-old traditions alive — the handcrafting of saris and the sculpting of Hindu deities, for example.
http://www.idrc.ca/reports/read_article_english.cfm?article_num=1083

India Shop
http://www.xlweb.com/indiashop/

Business e-tips for Rural African Women -- A new information tool offers direct access to information for women who are among the most marginalized in development -- poor women with little or no reading ability.
http://www.idrc.ca/reports/read_news.cfm?lang=e&article_num=1071

Planet Radio: Sharing Community Programming Over the Internet -- An international broadcasting association is helping community radio stations in the South use the Internet to strengthen their programming. The goal is to democratize the airwaves by helping small, often low-powered, community radio stations around the world produce and share radio programs featuring different viewpoints than those of mainstream media.
http://www.idrc.ca/reports/read_article_english.cfm?article_num=861

SchoolNet South Africa: Accessing a World of Learning -- In a country where almost 70% of schools are still without computers, SchoolNet SA has carved out a niche not just by making technology more available, but by focusing on historically disadvantaged schools. "The environment that SchoolNet finds itself in is one where racial relationships are fractured as a result of South Africa's history," says Executive Director Denis Brandjes. "As part of our mission, SchoolNet SA has chosen to focus on the use of ICTs to redress some of these injustices of the past, in order to bring about equitable distribution of resources and knowledge."
http://www.idrc.ca/reports/read_article_english.cfm?article_num=853

SchoolNet South Africa
http://www.school.za/

"**In a bookless society, why start with books?**" -- The telecentre with eight work stations is filled almost every working hour. Nurses prepare patient records. Teachers design lesson plans. Students write papers. Businesspeople produce signs for their stores. And Christopher Senono no longer has to make the 16-km return trip down the narrow country road on his bicycle to make a phone call for his business.

http://www.idrc.ca/media/Fuchs_e.html

Net Gains With Somos@telecentros -- A two-year-old Latin American and Caribbean co-operative that joins community Internet access centres, or telecentres, across the region is helping now-marginal sectors of society, such as the economically disadvantaged, to use the Internet to organize.
http://www.idrc.ca/reports/read_article_english.cfm?article_num=1017

Using the Internet to Help Street Children in Latin America -- Two non-profit organizations in South America are exploring how the Internet can help street children improve their lives. The Street Kids Project will provide children with tools in informal education, training, and alternatives for income generation. Already, the project team has established a street kids portal and an initial network, which may ultimately expand throughout Latin America and the Caribbean.
http://www.idrc.ca/reports/read_article_english.cfm?article_num=725

Reconceptualizing the Digital Divide by Mark Warschauer -- A fresh look at the problem. Warschauer suggests an alternate concept of technology for social inclusion and draws on the historical analogy of literacy to examine the resources necessary to promote access and social inclusion. 7,000-word article.
http://www.firstmonday.dk/issues/issue7_7/warschauer/

Taking the net to South Africa's poor
http://news.bbc.co.uk/1/hi/sci/tech/2057711.stm

Africans embrace mobiles and the net
http://news.bbc.co.uk/1/hi/technology/2290486.stm

Testing Telecentres in Mozambique
http://www.idrc.ca/reports/read_article_english.cfm?article_num=768

Improving Access to Telecommunications in South Africa
http://www.idrc.ca/reports/read_article_english.cfm?article_num=267

A Robin Hood for the Digital Age
http://www.idrc.ca/reports/read_article_english.cfm?article_num=1066

What the Internet is

To get back to the original question, we think Journey to Forever is a good example of what the Internet really is. This is a tough and challenging overland expedition to remote places which don't even have a telephone -- and yet schoolchildren in cities all over the world will be able to help us solve hard questions to help poor people

improve their lives and their communities.

The last millennium ended with war, cruelty, poverty, hunger, injustice, inequality, exploitation, pollution, environmental destruction, mass extinction, global warming, a hole in the sky -- and the Internet, its saving grace.

"No more turning away" -- Pink Floyd

The Internet

Why it really matters
Internet interaction
Finding your way in that Big Library in the Sky

Community development | Rural development
City farms | Organic gardening | Composting | Small farms | Biofuel | Solar box cookers
Trees, soil and water | Seeds of the world | Appropriate technology | Project vehicles

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Seeds of the world
No seeds, no food

Internet interaction

Forums are the Internet at its liveliest, where people meet, millions of them, every day and all the time. Forums are fun, they're useful, and there are lots of them, hundreds of thousands in fact, and more each day.

Forums are special-interest group discussions. They're self-help communities and clubhouses, and the natives are usually friendly. Use forums to find like-minded friends, swap ideas and share resources. For information, you can ask someone or you can search -- the discussions accumulate into databases that are a mine of useful information.

Many forums also have "FAQs", lists of Frequently Asked Questions on their subject-area with answers compiled by forum members -- another goldmine. Some people say the FAQs are the most useful source of information on the Internet.

There are four main kinds of forums: email mailing lists, Usenet newsgroups, World Wide Web forums, and real-time Chat channels. The Liszt list of lists lists 80,000 current mailing lists, 30,000 Usenet newsgroups and 25,000 IRC chat channels, and there are hundreds of thousands of Web forums.

Until recently you needed a separate newsreader program for the newsgroup forums, like you need a separate program for email, and the same applied to Chat, but these days you can cruise the big wide wonderful interactive world of the Internet that lies beyond the World Wide Web from within the comfort and safety of your own Web browser.

All forums are subject-specific, you write messages, you get replies, everyone else can see your messages, you can see their's, and it's all free.

Mailing lists

Once you subscribe to an email mailing list, all messages arrive automatically in your emailbox. (Set your emailer to filter each list's incomings to a separate mailbox. If your emailer can't do that, get one that can, like Eudora.) Most lists have an optional "digest" format so you get only one combined message a day instead of dozens (or hundreds) of individual ones, but you tend to follow the discussions less closely with digests.

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The Beach House fish pond
HOMeR
Eco-footprint
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Education resources on the Web
Children's poetry

Mailing lists are lively communities, friendly and helpful to newcomers. To join in, just reply to a message or "post" a new one: your message goes to the list's host computer (server) and then to all the other list members. Or you can "lurk", nobody will know you're there unless you say so.

Many lists are linked to a WWW home page with other resources, and many of these have searchable archives and FAQs. The thousands of mailing lists hosted by Yahoo! Groups, Topica and others also have a Web interface where you can read and post messages direct from your browser.

Yahoo! Groups
http://groups.yahoo.com/

Topica
http://www.topica.com/

Archives for the large collection of Listserv mailing lists can be searched by email, though many have web-based archives too. Search for Listserv lists at CataList Catalog of over 30,000 online discussion lists.

CataList Catalog of Listserv lists
http://www.listserv.net/lists/listref.html

The **Directory of Publicly Accessible Mailing Lists** (PAML) -- "the Internet's premier Mailing List Directory! We're better because we actively keep our mailing list entries up to date."
http://www.alastra.com/paml/default.html
FAQ on mailing lists and on PALM:
http://www.alastra.com/paml/answers.html
Search Form
http://www.taronga.com/cgi-bin/paml_search/

Newsgroups

The newsgroups are all to be found in one place, the Usenet, a global bulletin board with 30,000-odd sections. Usenet is a separate network within the Internet, but Web-based search engines provide smooth access to the newsgroups via the Web.

Use keywords to find the newsgroup you want or to search the text of all newsgroup messages: you get a list of "hit" messages, you can reply to them, see the other messages in that "thread" of

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discussion, see all the threads, and join in, without leaving your browser.

Google Groups: Search, view results, see full threads, respond, post new messages, browse complete list of Usenet groups -- full Usenet interface from your Web browser. 20-year Usenet Archive -- Building on the Usenet data previously acquired from Deja.com, Google has constructed what is believed to be the only complete 20-year archive of online discussion groups, extending more than 10 years prior to the birth of the web. The Google Groups archive contains more than 700 million postings in 35,000 topical categories.
http://groups.google.com/

NewsOne.Net offers free Usenet News access -- a threaded, Web-based newsreader showing ONLY actual Usenet newsgroups. Find and browse newsgroups, read postings, reply or post new messages.
http://newsone.net/

MailandNews.com provides web based access to over 30,000 newsgroups, including binaries. Requires a free subscription.
http://mailandnews.com/

Newsranger offers web-based Usenet discussion group access and posting. Users can set preferences, including newsgroups subscriptions, preferred reply address, signature file, and opening quote line. Also provides news client access, anonymous access, etc. Previously free, now fee-based.
http://www.newsranger.com/

Internet FAQ Consortium -- Usenet Frequently Asked Questions (FAQ) postings in Hypertext format: Full Text Search, By Newsgroups, By Category, By Author, By Archive-name, MultiPage Digested FAQs. Also For Your Information resources (FYIs), Requests for Comments (RFCs) and more.
http://www.faqs.org/

Complete FAQ list (hyperlinked) -- Usenet FAQs By Archive-name: eg, What is a dodo? The dodo FAQ is called "birds-faq/extinct/dodo - Dodo Frequently Asked Questions". (Big file -- 450kb.)
http://www.faqs.org/faqs/by-archive-name.html

Best place to browse Usenet newsgroups (Newsgroup Info Center):

http://metalab.unc.edu/usenet-i/hier-s/top.html

Usenet Help at the Newsgroup Info Center (NIC) -- everything about Usenet and newsgroups here, very useful.
http://metalab.unc.edu/usenet-i/usenet-help.html

Web forums

Web forums ("boards") are similar to newsgroups but the Web interface is slicker than Usenet's text-only format, and Web forums are easily linked to other Web resources. Less strict controls on advertising ("spam") than Usenet and the mailing lists. Some forums you must subscribe to, strangers are welcome at others. They're scattered all over the World Wide Web and proliferating fast -- there are hundreds of thousands of them.

BoardReader -- Connecting Message Board Communities: Searches the Web's forums and message boards, searches multiple message boards simultaneously.
http://www.boardreader.com/

Chat

Chat happens in real-time, like a telephone conference -- the people you're chatting with are actually there in front of their screens. It's snappy and immediate, lots of people love it.

Until quite recently, chatting meant using IRC (Internet Relay Chat) client software and locating an IRC channel. IRC chat is still the most popular, but Web-based chat is growing fast.

IRC Help -- all about IRC: FAQs, primers, guides, downloadable clients & scripts, server lists, site search.
http://www.irchelp.org/

Yahoo -- good list of Web-based Chat links.
http://www.yahoo.com/Computers_and_Internet/Internet/World_Wide_Web/Chat/

ICQ (I Seek You) is revolutionizing chat forums -- ICQ claims millions of downloads per week. People put their ICQ # on their business cards. The program runs quietly in the background while you work on other applications, and alerts you when your chat contacts log on (it also alerts them when you log on). You can connect with a click on the floating ICQ button. It also has a pager,

conferencing, email, and URL and file transfer.
http://www.icq.com/products/whatisicq.html

Virtual reality forums

For real virtual interaction, visit the real-time interactive virtual reality cyberscape of LambdaMOO (MOO -- Multi-user Object-Oriented dimension), where you can be whatever you like, and so can everyone else.

There's a warning on the gate: "LambdaMOO is a new kind of society, where thousands of people voluntarily come together from all over the world. What these people say or do may not always be to your liking; as when visiting any international city, it is wise to be careful who you associate with and what you say. The operators of LambdaMOO have provided the materials for the buildings of this community, but are not responsible for what is said or done in them."

Some MOO users have fallen in love and got married. Others lose their jobs and girlfriends because they spend 20 hours a day glued to the screen. But some of them re-emerge with confident new social skills they never had before and build life anew.

MOOs are also called MUVEs (Multi-User Virtual Environment) or MUDs (Multi-User Dungeons -- from "Dungeons and Dragons" games). They all stem from an ancient computer game -- the original computer game! -- called "Adventure".

Mostly still text-based and command driven via telnet (help available -- you have to learn how to use it), MOOs are moving towards a full multi-media interface. Eventually you'll be able to be a real-time 3D animation of whatever you like. This is where true cyberspace begins.

LambdaMOO
telnet://lambda.moo.mud.org:8888/

LambdaMOO Beginners Quick Reference
ftp://ftp.parc.xerox.com/pub/MOO/contrib/docs/quick-reference.txt

MOOs hit the Web

The **Diversity University Moo** allows the addition of graphics, sound, movies, and textual objects. It's a real-time virtual-reality campus, with dedicated buildings for most major academic

subjects and educational projects created by the DU community for individuals or whole classes. Uses the traditional telnet for text-only access or a multimedia connection via a clever integrated web and telnet interface (Cup-O MUD) using your web browser (needs Java and frames), placing an interactive MOO window in the bottom frame of your browser window. This is a real advance on telnet.
http://www.duets.org/

schMOOze University uses the same slick (Cup-O MUD) integrated interface as the Diversity University. It's a small, friendly college known for its hospitality and the diversity of the student population. Created for people studying English as a second language to practise and share ideas and experiences. Anyone interested in cross-cultural communication is welcome. More than 500,0005 visitors so far.
http://schmooze.hunter.cuny.edu:8888/

Free Classes in MOOing at the Diversity University:
http://www.primenet.com/~ctallis/myclasses.html

MOO Commands and Information -- basic MOO information, commands, and editors used at Diversity University, links to information about connections, telnet clients and other "net" resources.
http://www.northern.wvnet.edu/~tdanford/dumoo.html

Coming soon to a MOO near you: intelligent robots you can summon to your assistance -- now being developed.

Have a chat with a robot who thinks he's John Lennon:
http://www.triumphpc.com/john-lennon/

Chat with Alice the "chatterbot":
http://www.alicebot.org/

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Finding your way in that Big Library in the Sky

Most users mostly use search engines to navigate the Web, but there are thousands of search engines: how do you choose one? Even experienced searchers can learn from a visit to AskScott's very useful online Web Searching Tutorial -- it doesn't take long but it'll save you hours and you'll get better results.

As Scott says, "In general, you will be much more comfortable." That done, AskScott's very useful main page is a good place to start. It's not just a set of search-engine links, more like where you find the librarian.

AskScott's Web Searching Tutorial
http://www.askscott.com/tindex.html

AskScott main page
http://www.askscott.com/index.html

"Power Searching For Anyone" from Search Engine Watch tells you what you need to know about how search engines work.
http://searchenginewatch.com/facts/powersearch.html

Search Engine Watch -- Learn how to search better and how the major search engines work from a searcher's perspective. Search Engine Listings, Reviews, Ratings & Tests, Search Engine Resources, and Search Engine News, a free monthly newsletter with over 110,000 readers.
http://searchenginewatch.com/

• See **Education resources for teachers, students and parents** for Reference and research resources, Kidsafe search engines and more.

Search engines

Google -- Excellent, flexible search engine with many advanced features: search within results, view pdf files as html, language tools, news, image search, specialised searches, newsgroups archives and interface, and more.
http://www.google.com/intl/en/

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HOMeR
Eco-footprint
School and youth programs on the Web
Education resources on the Web
Children's poetry

AltaVista
http://www.altavista.digital.com/

Ask Jeeves -- Ask.com: Just type in a few words or ask a question.
http://www.ask.com/

The Internet Archive: Building an 'Internet Library' -- Search for vanished web pages via the Wayback Machine, just type in the url of the missing page. The Web archived from 1996 to now, 10 billion Web pages, 100 Terabytes.
http://www.archive.org/

Directories

Yahoo
http://www.yahoo.com/

LookSmart
http://www.looksmart.com/

Open Directory Project
http://dmoz.org/

Meta-search

Mamma is a "smart" meta-search engine, searches a series of other search sites at the same time, properly formatting the words and syntax for each, compiles their results in a virtual database, eliminates duplicates, and displays them in a uniform manner according to relevance. Search Web, News, Images, Audio, Kids, Power Search.
http://www.mamma.com/

MetaCrawler collates pages found on other search engines.
http://www.metacrawler.com/

Dogpile -- "All results, no mess". Metasearch of 13 WWW Search engines, also searches Web boards via BoardReader.
http://www.dogpile.com/

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Languages

The **Babel Fish** at AltaVista Translation -- Paste in some text and get a machine translation. Paste in a url and it will translate a whole web page for you. English to and from French, German, Italian, Portuguese, Spanish, plus Russian to English, German to French, French to German, and to and from English and Japanese, Korean and Chinese. You can test it by pasting in English text, translating to another language, then retranslating it back to English, with some hilarious results (especially with poetry) -- but it's not a fair test, and one-way translations work remarkably well. Very useful, despite some inevitable lapses and glitches.
http://babel.altavista.com/

Google has a new automatic translation feature, providing English access to a variety of non-English web pages -- available for pages published in Italian, French, Spanish, German. If your search has non-English results, there will be a link to a version of that page translated into English. Also,Translate text, or Translate a web page, search pages in any of dozens of languages and/or countries.
http://www.google.com/language_tools

International

Search Engine Colossus has links to 1,500 search engines from 196 countries. In English, French, Spanish.
http://www.searchenginecolossus.com/

News search

The **Global News Portal** at Mario's Cyberspace Station -- Vast news resources, searches of scores of news sources here -- a great news site by Mario Profaca, Croatian independent journalist. "Yes, the world is a sick place, and Mario Profaca is its webmaster" (The New York Times). BIG site!
http://mprofaca.cro.net/mainmenu.html

Google News and Resources -- 76 major news sources, US, national and international, plus Support, US Government.
http://www.google.com/news/

Google News -- Headline News, search and browse the latest

headlines -- World, US, Business, Entertainment, Technology, Sports, continuous updates throughout the day, results grouped with several sources.
http://news.google.com/

Yahoo! News -- Yahoo has good news resources, with lots of in-depth background stuff, special reports, roundups and related resources. Customisable email news delivery service.
http://dailynews.yahoo.com/
World news -- same in-depth treatment:
http://dailynews.yahoo.com/headlines/wl/

OnlineNewspapers.com - - links to more than 5,000 newspapers on the Web, worldwide, sorted by region and by country.
http://www.onlinenewspapers.com/

News Index -- "the original news-only search engine", search 300 news sources with links to full stories, plus other services such as personalized daily headlines delivered by email.
http://www.newsindex.com/

TotalNews -- Search current news stories from multiple sources.
http://www.totalnews.com/

Northern Light has a free real-time news search covering the past two weeks from 56 newswires, power search the archives for older stories.
http://www.northernlight.com/news.html

Excite News
http://news.excite.com/

Excite NewsTracker
http://nt.excite.com/

Advanced Web Search

Search websites that don't have site-search with **Google Advanced Search**. Select "Domains -- Only return results from the site or domain..." and enter the url of the site you want to search. Search terms can be with all of the words, with the exact phrase, with any of the words, or without the words you enter. You can also find results in a specified language, in web

pages updated at a specified date, or where your search terms occur a specified number of times. Also News search (beta), Image search (beta), find similar pages, or specialized searches on the following topics: Apple Macintosh, BSD Unix, Linux, all US Government and .mil sites, and US Universities: Stanford, Brown, BYU, & more.
http://www.google.com/advanced_search

Search PDFs

Adobe PDF Search -- Search over 1 million Acrobat PDF files on the Web.
http://searchpdf.adobe.com/

Search Web boards

BoardReader -- Connecting Message Board Communities: Searches the Web's forums and message boards, searches multiple message boards simultaneously.
http://www.boardreader.com/

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Schools participation

**"The earth was not given to us by our parents,
it was loaned to us by our children."
*-- Kenyan proverb***

Schoolchildren are a special part of Journey to Forever -- participation is open to schools everywhere, and it's free.

Schoolchildren can share our adventures via the World Wide Web. They'll find themselves working over the Internet to help us solve real problems affecting the lives of real people.

Participation won't be just a token: if schools groups think we're doing something wrong and they've got a better idea, then we'll do it their way!

IT education is at the core of the project: students will use information technology in new and creative ways, while linking and collaborating with children in other lands, sharing views, making new friends, and learning together.

-- "Information Technology is not a subject -- it is a whole new educational culture." -- Au Pak Kuen, Vice-president, Hong Kong Professional Teachers' Union

-- "I've learnt more than I ever could from a book!" -- comment by AT&T Virtual Classroom student

Journey to Forever has "viewer appeal" -- the sense of an unfolding adventure, interactive communications, and a highly involving content make learning fun, and easy. And children care about the issues we're involved in. We'll help them make a difference.

Schools project structure

Schools can participate at three levels:

- the environment and development projects we'll be working on in the field
- special schools projects related to our main work
- background studies

This provides an ongoing series of linked schools projects catering for all levels and covering a wide range of subjects, with background and other resources provided online.

The team's professional writers and photographers will produce the

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Japan

project material and deliver it via high-speed mobile satellite link to our co-ordination centre, which will run the Journey to Forever Website and manage schools resources.

The communications link will work both ways, providing interactive participation in all phases of the expedition via Internet forums and online "chat" discussions, and even real-time video conferencing. Via satellite link, we'll take participating schoolchildren into classrooms in villages very far from anywhere.

We'll also foster community and school projects in centres along the route, such as energy and environment projects, waste-recycling and urban farms, and we'll set up information-sharing networks between different centres, involving local schools and all our school participants.

Where sponsorship is available, we'll arrange for small groups of students to join the expedition for short periods, gaining actual field-experience.

-- "The most effective way of all to teach kids about what life is like in developing countries is to take them there. We've done that before and it was quite remarkable, it really was a life-changing experience." -- John Sayer, Director, Oxfam Hong Kong

Languages

The main project language is English, and for non-native speakers all schools projects can be used to enhance English-language teaching.

However, we do not want the project closed to all but English-speaking students. We're now building sister-Websites in other languages, and investigating translation options.

We already have a Japanese website and a Chinese website under construction, the Biofuels section is available in Spanish, and we'll add others as soon as possible.

Journey to Forever Japanese site
Journey to Forever Chinese site
Biofuels in Spanish

Schools projects

(All our school projects include IT education.)

Biofuels
Solar box cookers
Backpack stove

PicoTurbine
Low-tech radio
What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox
School gardens
School composting
Trees and forests
The Beach House fish pond
HOMeR -- Handmade Organic Mosquito repellent
Eco-footprint
School and youth programs on the Web
Education resources on the Web
Children's poetry

Biofuels

Our work with biofuels has four main aims:

- Finding clean, renewable fuels for our vehicles;
- Helping to find ways to clean up the air in polluted cities;
- As an environmental project for schools participating in Journey to Forever;
- As a means of improving energy self-reliance in rural communities.

Biodiesel and ethanol are clean, grow-your-own fuels made from plants, and they can be made in small villages, in a kitchen, or in a school laboratory. The wonderful thing about these fuels is that the by-products can still be used as food products, so no one has to starve because we're making fuel instead of food. We'd be making both!

Making biodiesel in the kitchen.

Biodiesel

-- how to make the school bus exhaust smell like French fries

Cities are choking on air-pollution, and one of the main culprits is the exhaust smoke from diesel engines.

But diesels are the most economical engines by far, and transport industries rely on them. Scrapping diesels would raise the costs of just about everything and make everyone's life tougher.

There is one solution which could bring immediate benefits -- biodiesel. Biodiesel is a clean, environmentally friendly diesel fuel, "more biodegradable than sugar, less toxic than table salt".

We make our own biodiesel in our kitchen -- out of used cooking oil! We used it in one of our Land Rovers. You can make it too, in the school laboratory. See:

Make your own biodiesel -- Journey to Forever.

Mike Pelly's biodiesel recipe -- this is the best how-to on the Web.

Aleks Kac's two-stage process -- high quality fuel and no titration!

FOOLPROOF biodiesel method -- by Aleks Kac

Biodiesel -- education links

Biodiesel resources at Journey to Forever:

Biofuels

Biofuels Library
Biofuels supplies and suppliers

Biodiesel
Make your own biodiesel
Mike Pelly's recipe
Two-stage biodiesel process
FOOLPROOF biodiesel process
Biodiesel processors
Biodiesel in Hong Kong
Nitrogen Oxide emissions
Glycerine
Biodiesel resources on the Web
Do diesels have a future?
Vegetable oil yields
Bubble washing
Biodiesel and your vehicle
Food or fuel?

Biodiesel pages in Spanish at our partner site.

Ethanol

What about the pollution from car engines? Most cars have petrol

engines (gasoline), not diesel, and they don't smoke as much, but they still pollute the air with deadly fumes.

Ethanol is a good substitute for petrol: it's a clean, high-performance fuel that cuts poisonous exhaust emissions and is much better for the environment.

Ethanol is made by fermenting and then distilling starch and sugar crops. Here's how to make it in the school lab:

"Ethanol -- As A Fuel", comprehensive study project from the Northwest Iowa Community College, including laboratory production of ethanol. Ethanol Curriculum for Teachers (Grades 9-12)
http://www.nwicc.cc.ia.us/etsp.htm

Ethanol from plants -- Ethanol Study Course, resources for teachers, from Australia's New South Wales Higher School Certificate (Stage 6) syllabus
http://www.kcpc.usyd.edu.au/discovery/9.2.3-short/syllabus.html

Ethanol Car: Building the 'Stirly, the Little Engine that CAN' -- Stirly was designed as an educational model to demonstrate how biomass fuels (clean and renewable fuels made from plant materials) can be used to power vehicles. It is meant to inspire people into thinking about alternatives to fossil fuel energy. It is also meant to promote a very exciting and promising sustainable technology for not only locomotion, but also heating, cooling, and power generation, namely, the Stirling engine. here's how to build a Stirly, using a tin can, a few balloons, a rubber band, a paper clip, a hoseclamp, a fondue burner, some copper wire, fishing line, bits of wood and plastic and other stuff, duct tape and Superglue.
http://www.eya.ca/mainresources/energymodels/biomass/ethanolcar.htm

Build A Tin Can Stirling Engine -- by Mr.Saburo Tsucchida of Kasukabe technical high school in Japan. Full instructions and diagrams.
http://www.bekkoame.ne.jp/~khirata/english/mk_can.htm

Energy Quiz -- from the Energy Information Administration, US Department of Energy: 15 multiple-choice questions with "Find the answer first or look at the Quick Answer List."
http://www.eia.doe.gov/kids/energyquiz.html

Fuels and Society -- General Chemistry Case Study Curriculum Supplements:
a. Chemistry and History of Automotive Fuels
b. Sixty Years of Tetraethyllead
c. How Lead was Finally Removed from Gasoline
http://chemcases.com/

The Secret History of Lead -- Special Report, by Jamie Lincoln Kitman : 27,000-word investigative report, The Nation March 20, 2000
http://www.globalleadnet.org/advocacy/initiatives/nation.cfm

More ethanol resources here.

Biofuels

Biofuels Library
Biofuels supplies and suppliers

Ethanol

Ethanol resources on the Web
Is ethanol energy-efficient?

Solar box cookers

Half the inhabitants of Earth cook over woodfires -- 45% of the world's wood is used as fuel. And nearly 2.4 billion people are now facing shortages of fuelwood. Meanwhile deforestation helps cause climate change, floods and soil erosion, increasing environmental degradation, and increasing poverty and hunger.

There's one simple answer to these problems, that can save millions of trees, provide clean, safe drinking water, doesn't smoke, and that costs just about nothing -- solar box cookers, made from cardboard cartons.

Solar rice for lunch! Free energy!

Solar box cookers for schools

Solar box cookers
Solar cooker resources on the web

Backpack stove

Here's how to make a camping stove for your backpack that weighs just about nothing and takes up hardly any space.

These little stoves are great -- they're fun to make and it only takes a few minutes. Not just a toy -- they really work! They put out a hot ring of blue flame like a gas stove and hold enough fuel for about 15 minutes -- so if you're cooking something that takes longer than that, better make two so you can alternate them to keep up the heat.

All you need is a couple of aluminium soft-drink cans, some perlite, a wire coat-hanger and a bottle of denatured alcohol (spirits, usually dyed purple).

Backpack stove -- full instructions.

Make a **Hobo stove** with a one-gallon paint can and a pocket knife.

PicoTurbine

This is a great energy project! Make a miniature, 8" (20 cm) high, wind-driven power generator. Midori made one out of a pencil, a wire coat-hanger, a bit of wood, an old CD, some paper and cardboard, four magnets, and some other bits and pieces.

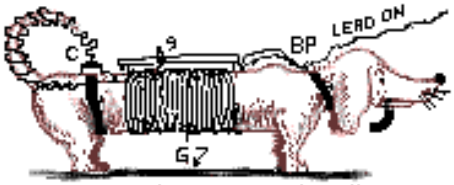
Or you can buy a special kit. "The PicoTurbine can produce 1/3 watt -- that's a lot of power when converted to education!"

PicoTurbine page

Low-tech radio

Listen to AM radio on a crystal radio set you can build yourself for only a few dollars. Crystal radios don't need a power supply -- they're powered by the radio waves they receive!

Crystal radios were discovered in 1901 and are still the basis for most modern-day radio apparatus. For this reason, a study of crystal sets is a great place to start to build a foundation in radio electronics.



You can make a crystal radio out of anything (Xtal Set Society)

Building them was a craze in the 1920s, and again in the 1950s, and now it's happening all over again.

Here's where to start: online resources, plans and instructions for different models you can build -- from a cereal packet, a cigar box, and a computer cable.

Crystal radio page

What to do with a cardboard carton

Which is best?

1. Throw it in the garbage
2. Send it to the waste-recyclers

3. Turn it into a solar box cooker
4. Use it instead of an oven to bake sweet potatoes
5. Turn it into a composter that finally composts itself -- and grow a tree in the compost you make
6. Feed it to compost worms
7. Make a Growing Column and grow 50 vegetables in it
8. Hatch 3 dozen eggs in it -- make an incubator.
9. Make an armchair
10. Build a house.

There are lots more, this list will keep growing -- can you add to it?

We started another list like this, listing the ways people use empty oil drums, but we soon gave up -- it would be too long!

Why don't you try it? See how many empty oil drums you can spot being used for different purposes in your neighbourhood -- it will help you to open your eyes to recycling opportunities. They're the big, 55-gallon (US) steel drums. They're everywhere, but nobody notices them.

Let us know what you find -- we'll keep count.

What to do with a cardboard carton

Sisters of silk

-- Hong Kong's Chinese amahs

Chinese "amahs" (domestic helpers) first gained their economic independence through the silk boom in the rural areas of Guangdong at the start of this century. When the silk boom ended, they formed sisterhoods, took anti-marriage vows, and devoted themselves to domestic service.

Drawing by Christine Thery

Now there are only a few of them left, and the fascinating history of these women and their unique way of life will soon be lost forever.

A social research and oral history project mainly for Hong Kong schools to help capture a special part of local history before it fades away.

- oral history
- civic education
- social research

- women's issues
- using personal and family networks

Other communities have started to use our Sisters of Silk project as a model for similar work in their own societies. The context is quite different, but the model is easily adapted to new tasks.

Is there a part of living history in your community that's fading away, a group of old people whose lives were part of something special that's now past? Don't let their memories die, show them you care. Please contact us, we'll help you if we can.

Sisters of silk -- Hong Kong's Chinese Amahs

Silkworms in a shoebox

-- part of the Sisters of Silk project

Projects:

- from eggs to caterpillars to silk cocoons to moths to eggs
- make your own silk
- nature, ecology, environment
- resources, teaching materials, equipment, references, history, silk around the world, silk in rural development

Silkworms in a shoebox
Mulberry trees
Kids' crazes

School gardens

Handmade Projects' innovative organic growing system is ideal for schools gardens and as a resource for school biology and environment projects. This system can even be adapted to conditions in Hong Kong schools which don't have school grounds.

The garden at our Hong Kong headquarters, the Beach House on Lantau Island, demonstrates that you can build a beautiful organic food garden on top of cement without any soil -- you make your own high-quality soil by recycling food scraps and waste.

Journey to Forever garden

Hundreds of great projects, online and in books.

- how to start a school garden -- indoors or outdoors

- gardening and waste-recycling (turn kitchen scraps into fertile new soil)
- composting, vermicomposting -- kids just love this! (See School composting, below)
- what it takes to grow a meal

All gardening projects integrate well with the rest of the curriculum and enhance studies in a wide range of subjects.

See **School gardens page**
School gardening resources
Trees and forests -- resources for schools

School composting

Kids love composting and vermicomposting projects! Gardening and composting go hand-in-hand, especially in school garden projects: gardening without composting only teaches half the lesson.

Composting concerns the invisible half of the Wheel of Life, Nature's cycle of growth and decay. This is the vital part that happens underground, where wastes decay to give rise to new life.

The complete lesson from which children can benefit the most includes the full round of growth and decay, how the one depends on the other, and how, together, they compose a vivid example of the health, balance and sustainability of a natural system at work.

Great schools composting resources online.

School composting

Trees and forests

Without trees, we are doomed. Nothing symbolises Mother Nature and how our environment is threatened better than trees and forests, and especially rainforests. Via the Internet, schools and children can get actively involved in saving trees -- and learning in depth exactly why it's so important.

Here are the best resources available:

Trees and forests -- resources for schools

The Beach House fish pond

"Aren't you breeding mosquitoes in that bathtub? Why're you growing water hyacinth? It's a terrible pest." -- Craig Leeson, journalist.

Projects:

- Make your own garden pond -- a whole ecology in four square feet
- What are weeds?
- What are pests?

This project has a lot of depth -- more depth than our fishpond (which has no fish...).

Beach House Fish pond
Garden pond
Aquaculture for small farmers

Handmade Organic Mosquito Repellent (HOMeR)

The Thai lemon grass in our herb garden grows nearly two inches a day -- and we found it keeps the mosquitoes away. We've also found that it's an effective herbal anti-fungal medicine (lemongrass tea) and in Puerto Rico people use the fibrous stalks as a natural toothbrush! But how can its essence be extracted and preserved without losing its magic? We use a tincture we make with Chinese brandy. It works well -- but can you find a better way?

Subjects:

- Herbs, food and medicines
- Botany, chemistry
- Threatened plant resources

"The world's most dangerous animal is the mosquito." -- BBC World Service health program: millions die every year of malaria, and with increasing drug resistance, the problem is worsening, while attempts to control the mosquitoes with pesticides have proved ineffective.

- three-quarters of modern medical drugs are plant-based
- most plant species haven't yet been studied for their potential medical benefits
- thousands of plant species are lost forever each year because of deforestation and industrialized farming methods.

Handmade Organic Mosquito Repellent (HOMeR) page

Eco-footprint

Are you too big for your boots? How heavily do you tread upon the world?

Your ecological footprint is the amount of land it takes to support your way of life, your lifestyle.

The worldwide average per capita footprint is 2.4 hectares, or 6 acres. If we leave only 12% of the biosphere for other species, there are less than 2 hectares available per person, or 5 acres each -- this means that we humans overshoot the mark by at least 20%.

That's a very important number -- it's the measure of just how "unsustainable" we are. This is why environmental issues are so important.

Let's see how you measure up. Includes guidance on how to make your footprint smaller.

Eco-footprint

Schools programs

These are the major international programs for schools and students on the Internet.

Schools and youth programs on the World Wide Web

Schools resources

Search engines, libraries, resources, thousands of schools projects, games, communications -- for teachers, for students and for kids.

Educational resources for teachers, students and parents

Children's poetry

An open invitation to young poets to send us their favourite poems -- we'll publish them in this special section of our website.

Children's poetry

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Sun power saves lives and trees
Trees, soil and water
Healthcare for mountains
Seeds of the world
No seeds, no food

School and youth programs on the World Wide Web

ePALS Classroom Exchange -- The World's Largest K-12 Online Classroom and electronic penpal network, connecting 3.8 million students and teachers in more than 65,000 registered classrooms in 191 countries. Set up a free classroom profile and ePALS Web email account to collaborate on school and cultural projects, learn language skills and make friends worldwide. In English, French, Spanish, German, Portuguese, Japanese. Search for ePals or classrooms by country, by language or by keyword.
http://www.epals.com/

Meeting Place is an online forum with thousands of messages from children discussing issues that affect them, such as children working in factories or on the street, how war affects children, growing up as a girl, living in the city, and more. Meeting Place shares a home page with Learning Place and Teachers' Place, all part of Unicef's Voices of Youth project. Online classrooms, resources, archives, site search, links.
http://www.unicef.org/voy/meeting/meethome.html

Kidlink is a free eight-month multi-lingual educational schools program to help children get involved in a global dialog. It's a set of 77 email mailing lists for group discussion, a private real-time chat network and an online kids' art exhibition, run by a worldwide network of volunteers, mostly teachers and parents. More than 175,000 kids from 144 countries on all continents have participated, in 19 languages. Participants must submit personal presentations and views on the desired future of this world. "Now you have tasted the wonders of a global classroom. Now when you see the name of one of these countries in the evening news or in the newspapers, you will feel different: you will feel involved." Plenty of support online.
http://www.kidlink.org/

Junior Summit says the world's children are not consulted on too many issues that affect them and their future, and aims to change that, offering children "a platform to effect real change". The first summit was in Tokyo in 1995. The second started with a global invitation from the MIT Media Lab to nearly a million young people, with 8,000 replying. Nearly 3,000 of them from 139 countries joined an on-line forum in September 1998, and 100 of these from 54 countries attended the six-day Junior Summit in

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November 1998 at MIT in Cambridge, Massachusetts. Delegates' presentations online (multi-media). Online Resource Bank database and forum for finding solutions to problems children face, Junior Journal monthly global newspaper, a new virtual country for children -- Nation1 (http://nation1.net), and other initiatives and resources online. In nine languages.
http://www.jrsummit.org/tpls/press.wpi?pageID=982008100615EN

The World Bank's **World Links for Development** (WorLD) program promotes "connectivity" for developing country secondary schools, helping them to procure and install the necessary hardware and software and linking them with schools around the world. Partner schools, projects, content and training.
http://www.worldbank.org/worldlinks/english/index.html

I*EARN (the International Education and Resource Network), a partner in the World Bank's WorLD Program, enables young people to undertake collaborative projects contributing to the health and welfare of the planet and its people. Site search, Interactive forums, Member/Project databases, Language resources, professional development, and more.
http://www.iearn.org/

The **GLOBE** Program (Global Learning and Observations to Benefit the Environment) is a worldwide Internet-based network of students, teachers, and scientists working together to study and understand the global environment. Over a million primary and secondary students in more than 10,000 schools in 96 countries have taken part in the program; there are now more than 16,000 GLOBE-trained teachers.
http://www.globe.gov/

Earthwatch Global Classroom has project resources on endangered ecosystems, oceans, biodiversity, cultural diversity, global change, world health, origins of the future. Scholarships for K-12 teachers and high school students to participate in Earthwatch expeditions, students nominated by teachers are eligible for student research teams. Expedition photos, reports, and lessons online. Focus mainly on the Americas.
http://www.earthwatch.org/ed/home.html

The **Odyssey World Trek** follows a team of adult volunteers around the world on a two-year trek, spending six weeks in each of 10 non-Western centres and documenting their experiences and the lives and perspectives of the people they meet in video, audio, photos and text. Content is posted on The Odyssey website for students to follow. Students can also interact with the team, the

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Handmade Projects
Ichijima
Japan

people they meet, and each other. Includes lesson plans and teacher guides.
http://www.worldtrek.org/

A SEED (Action for Solidarity, Equality, Environment and Development) involves young people in the struggles against ecological destruction and social injustice. Formed in 1991 in the run-up to the Earth Summit (UN Conference on Environment and Development in Rio de Janeiro, Brazil), A SEED has grown into a global network linking youth and student groups active in the field of environment, development and human rights.
http://www.aseed.net/

Youth Environmental News Desk -- Environmental news reports by people up to the age of 19, published and distributed worldwide by the Environment News Service (ENS) and featured on the Horizon Solutions Site. Entries invited from all countries. Reports will be translated and distributed in Spanish, English, German, Portuguese, Swedish, Mandarin, Swahili, French, Nepali, Punjabi, and Hindi. Send your report with a brief personal resume to the ENS editorial desk at news@ens-news.com. Email only, put the words "Youth Desk" in the subject line.
http://www.solutions-site.org/youthdesk.htm
Also, **Solutions Site for Kids** -- case studies, Learn and Do, ongoing Contests, chat room, discussions and projects under Talk. "Become a member of our Youth Advisory Board!"
http://www.solutions-site.org/kids/default.htm

Community development | Rural development
City farms | Organic gardening | Composting | Small farms | Biofuel | Solar box cookers
Trees, soil and water | Seeds of the world | Appropriate technology | Project vehicles

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Sun power saves lives and trees
Trees, soil and water
Healthcare for mountains
Seeds of the world

Education resources for teachers, students and parents

Education World -- "Where educators go to learn", also useful for self-learners young and old. Search for a topic in the database of 500,000 teaching resources on the Internet. Curriculum, Lesson Planning, Site Reviews, Teacher Lessons, and much more. Comprehensive site.
http://www.education-world.com/

Awesome Library -- searchable education web directory of more than 17,000 reviewed resources, including the top 5% education websites. Easy interface. By the Evaluation and Development Institute in the US.
http://www.awesomelibrary.com/
"Ask a Question" page links to dozens of expert websites on a variety of subjects, includes Homework Helper.
http://www.awesomelibrary.org/Office/Main/Involving_Students/Ask_a_Question.html

Blue Web'n is a searchable database of about 1,000 outstanding Internet learning sites categorized according to subject area and type: tutorials, activities, projects, unit and lesson plans, hotlists, other resources, references and tools.
http://www.kn.pacbell.com/wired/bluewebn/index.html

The **Community Learning Network** is designed to help K-12 teachers integrate technology into their classrooms. More than 265 menu pages with more than 5,800 annotated links to free resources on educational WWW sites, in an "intuitive structure". Educational WWW Resources for K-12 Students and Teachers, Integrate the Internet into the Classroom, Learn More about the Internet, Professional Development in Information Technology. Good interface, easy to find what you want on this well-organized Canadian site. More than 16 million visitors from 165 countries since 1996.
http://www.cln.org/
General Education Meta-lists / WWW Directories -- links to multi-subject Internet directories of K-12 curriculum resources (some reviewed, with descriptions).
http://www.cln.org/subjects/general_cur.html

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Collections of Lesson Plans -- links to sites with extensive lesson plan collections.
http://www.cln.org/subjects/general_inst.html

AskERIC -- Funded by the US Department of Education, the Educational Resources Information Center (ERIC) provides a Virtual Library of selected educational resources, including 1,100-plus AskERIC Lesson Plans, more than 250 InfoGuides, searchable archives of education-related listservs, links to Television Series Companion Guides, database search, and a personal email response on any educational question from educators, librarians, parents, or anyone interested in education, with a Hot Topics archive.
http://www.askeric.org/

StudyWeb Meta-Encyclopedia for Student Research -- categorized web centre of 162,000+ "Research Quality" URLs -- database search or browse large subject list. Resource directory, subject-specific homework help online (good list), teaching resources.
http://www.studyweb.com

The **AT&T Learning Network** supports and develops programs and resources for teaching and lifelong learning through technology. The Virtual Academy is a centralized resource of online courses to help educators integrate technology into the curriculum, and to update their professional credentials, options from upgrading skills to college degrees. Online Resources for Educators has a large array of educational resources on the Web -- lesson plans, online projects, teaching aids, and more. Resources for Families has a wide variety of links to family-related educational content. Also Community Guide to the Information Superhighway. Lots of good resources here.
http://www.att.com/learningnetwork/

Lightspan.com education portal for educators, parents, and students, providing resources, research tools, and grade-specific activities. Educational research compiler with over 115,000 grade-appropriate, expert-selected sites, allows users to search for Web sites, lesson plans, encyclopedia articles, and projects. Plus the Lightspan Network paid subscription service.
http://www.lightspan.com/

Global SchoolNet (GSN) locates and publishes projects from Internet sites around the world, from projects designed by

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individual teachers to major projects sponsored by public and private sector organizations. Site search, projects search. Now a part of Lightspan.
http://www.lightspan.com/teacher/pages/projects/default.asp?_prod=LS&_nav=T2_proj

Global SchoolNet's **Newsday** -- Involve your students in international affairs with Newsday newswire. They'll create their own newspaper based on articles submitted by global student correspondents. Current theme: The Future -- What does the world of the future hold for us? What is your "world vision?" What sort of world will this be in a few thousand years? In ten years?
http://gsh.lightspan.com/project/newsday/index.html

Marcia's Lesson Links -- a great list of lesson plans and educational websites ... by a teacher, for teachers -- especially for those who have a hard time searching the Web. Lots here for parents too, and for kids.
http://members.aol.com/MGoudie/index.html

KidSource OnLine -- In-depth education and healthcare information for parents (with site search engine):
http://www.kidsource.com/index.html
My KidSource -- Free daily E-mail Parenting Tips: educational activities; healthcare, parenting or education tips; news about websites and products. Subscribe:
http://www.kidsource.com/subscribe.html
Twenty online forums for parents and educators:
http://www5.kidsource.com/forums
Timeless Classics -- Good selection by the US National Endowment for the Humanities of more than 450 books, graded for Kindergarten through Grade 6, Grades 7 and 8, Grades 9 through 12:
http://www.kidsource.com/kidsource/content/timeless.html
Learning Disability Search Engine (offsite, selected sites):
http://www.kidsource.com/kssearch/ldsearch.html

TEAMS Distance Learning for K12 Educators (Los Angeles County Office of Education) lists many interactive Internet projects students and schools can join online.
http://teams.lacoe.edu/documentation/projects/projects.html
Electronic classrooms, K-12 Lesson Plans, Parent Resources, The Reading Village, Libraries & References and more:
http://teams.lacoe.edu/

Reference and research

-- The only dumb question is the one you don't ask.

Internet Public Library Reference Center -- Search for information in online newspapers and periodicals, books, Internet resources and more, or ask a question. Archives of Frequently Asked Reference Questions, large collection of ready references, grouped by subject area, large number of subject-specific "Pathfinder" guides written by IPL staff to help you get started doing research on a particular topic, online or at your local library. Good place to start a research project or a simple information search.
http://www.ipl.org/ref/

Librarians' Index to the Internet, California State University -- "Information you can trust". Searchable subject directory of more than 8,200 Internet resources selected and evaluated by librarians, with detailed annotations. Meant for both librarians and non-librarians. It started life 10 years ago as a librarian's bookmarks file. Search or browse the 1,587 subject areas, from Abacus to Zoroastrianism.
http://lii.org/
LII New This Week free weekly mailing of the top 20 resources added to the LII, more than 10,000 subscribers in 85 countries.
http://lii.org/search/file/mailinglist

Freeality Online Encyclopedias -- single interface for searching 23 online encyclopaedias, with links to a dozen more, plus dictionaries, libraries, thesaurus, English language tools, translation dictionaries, glossaries and more. Also reference and research links and other resources.
http://www.freeality.com/encyclopt.htm
Freeality's Internet Oracle Online Homework Helpers:
http://www.freeality.com/online_homework_helpers.htm

Britannica.com -- online version of the famous encyclopaedia. Slick search engine finds relevant Encyclopaedia Britannica articles, related articles, and a range of related magazine articles and websites. High-quality information resource.
http://www.britannica.com/

MAD Scientist Network fields questions in 26 areas of science. Hundreds of scientists unite in a forum where people can

ask questions and learn more about the world around them. Archives holds more than 25,000 answered questions listed according to subject areas and grades (from K-3 to professor). Search engine searches archives and/or library.
http://www.madsci.org/circumnav/
Submit questions:
http://www.madsci.org/submit.html

About.com -- Network of information sites led by expert guides to help you find and learn. Large number of subject areas with good directories, and a search engine delivers a menu of annotated links plus related links and resources.
http://about.com/

Learn2.com -- Many step-by-step "2torials" on a wide variety of subjects, from basic skills in daily life (fry an egg, catch a mouse) to dealing with technology. Each of 12 learning "channels" has an associated "Learnlines" discussion forum for questions and answers. Also Survival Guides, collections of tutorials to avoid potential crises. Useful, if not strictly "educational" -- what you didn't learn in school and probably should have.
http://www.learn2.com/learn2_everyday.asp

How Stuff Works -- Answers your hows and whys with clear, well-written articles, along with related links and resources. Complete list of all articles, word or concept site search, Question of the Day (plus archive), monthly newsletter, books on how stuff works. Read hundreds of questions other people asked at the Question Archive: What exactly is pastrami? Do jumbo jets have ignition keys? Can I get AIDS from a mosquito bite? What makes super glue so super?
http://www.howstuffworks.com/index.htm

Kidsafe search engines

Yahooligans -- Yahoo's web guide for kids
http://www.yahooligans.com/

CyberSleuth-Kids.Com -- online search engine and guide for K-12 students, made by teachers and the volunteers.
http://cybersleuth-kids.com/

KidsClick! was created by librarians as a guide for young users to valuable and age-appropriate web sites. Search, browse a large

list of subject areas, and the Worlds of Web Searching site for lessons and activities to help learn searching skills.
http://sunsite.berkeley.edu/KidsClick!/

Home schooling

-- "**IF you happen to be** one of those parents who is considering homeschooling your kid because he either isn't doing well in public school or you think he might be better off at home, but you are intimidated by all the arguments against it (you feel unqualified to teach, you feel you might not have enough time, your kid might be too isolated, etc. etc.)... it can be done." (Lee Flier)

Kids Taught at Home Make the Grade
August 30, 2000 (Fox News) -- For the third consecutive year, [US] ACT college admissions test scores are higher for homeschoolers than for other students. Homeschoolers' average composite score was 22.8, compared to the national average of 21, out of a possible 36. On the SAT, homeschoolers, who comprise less than 1 percent of test takers, earned 568 verbal and 532 in math. The national average, announced Monday, was 505 verbal and 514 math. The U.S. Department of Education estimates there are between 1 million and 1.2 million homeschoolers in America.

The World According To Gatto (Education Week, March 2001) -- John Taylor Gatto quit his profession -- and explained his reasons for doing so in the Wall Street Journal -- almost immediately after winning the New York State Teacher of the Year Award in 1991. Today Gatto's central message is that families should shake off their public school dependencies and take charge of their own education.
http://www.educationweek.org/tm/tmstory.cfm?slug=06gatto.h12

Seceding From School: The average home schooler's SAT score is 1100, 80 points higher than the average score for the general population. The new home schoolers aren't hermits. They are diverse parents who are getting results -- and putting the heat on public schools. -- Time Magazine, cover story
http://www.time.com/time/covers/1101010827/cover.html

Home Schooling Teaching Resources at StudyWeb -- lots of help here for homeschoolers. The web makes all the difference! Curriculum & Online Resources:

http://www.studyweb.com/links/1383.html
Lesson Plan Sites:
http://www.studyweb.com/links/5251.html
Homeschooling Support Groups & Organizations:
http://www.studyweb.com/links/1319.html

Finding Homeschool Support on the Internet -- lessons, how-to's, getting started, email mailing lists, chat groups and forums, lots of resources and support for homeschoolers.
http://www.geocities.com/Athens/8259/

Homeschool Resource Pages (Home Education Magazine) -- homeschooling news and information, support and encouragement, resources: Information and Resources Guide, Homeschool Resources, Online Newsletter, Information Library, Discussion Boards.
http://www.home-ed-magazine.com/

Jon's Homeschool Resource Page -- One of the oldest homeschooling sites on the Web (six years old) and one of the most extensive. Homeschooling handbooks online, a big list of Frequently Asked Questions, lists of News Groups, Mailing Lists, Web forums, Chat Channels, Web Resources, Organizations and more.
http://www.midnightbeach.com/hs/
Join the home-ed mailing list for 'how to' and 'should we', curriculum questions, etc:
http://www.madrone.com/Home-ed/hewelcome.html

Pontiac High School -- "Improving the community one kid at a time": A collection of a California family's journey educating their son themselves, and practical information on helping others to get started homeschooling. Useful site, interesting articles, resources.
http://www.ronnieuggie.com/pontiac.htm

Homeschooling Resources (mostly science) -- links to homeschool and alternative education sites, homeschool magazines and journals, "curriculum swap" sites, homeschooling articles, kids' science projects, curriculum and lesson plans and more.
http://www.eskimo.com/~billb/home.html

Common Sense Press -- publisher of easy-to-use material for Homeschoolers.

http://www.cspress.com/

Homeschooling Forum -- active web forum "for those schooling children at home to share their experiences and techniques", many messages and threads. Message archive search facility.
http://www.thathomesite.com/forums/homesch/

Federal Resources for Educational Excellence (US):
http://www.ed.gov/free/
Each category has many valuable links, for example, here's the Science page:
http://www.ed.gov/free/s-scienc.html

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Work at it first, don't be in a hurry, have another look, see if it really says what you want it to say, clearly, without wasted words. Trim it if you can, try putting it another way to see if it works better. When you're REALLY happy with it, send it to us at:
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LEMONGRASS

Family: Poaceae (Gramineae), *Cymbopogon* species

Source: Simon, J.E., A.F. Chadwick and L.E. Craker. 1984. Herbs: An Indexed Bibliography. 1971-1980. The Scientific Literature on Selected Herbs, and Aromatic and Medicinal Plants of the Temperate Zone. Archon Books, 770 pp., Hamden, CT.

Lemongrass, a perennial herb widely cultivated in the tropics and subtropics, designates two different species, East Indian, *Cymbopogon flexuosus* (DC.) Stapf., and West Indian, *Cymbopogon citratus* (DC. ex Nees) Stapf. East Indian lemongrass, also known as cochin or Malabar grass is native to India, while West Indian lemongrass is native to southern India and Ceylon. The lemongrasses are cultivated commercially in Guatemala, India, the People's Republic of China, Paraguay, England, Sri Lanka, and other parts of Indochina, Africa, Central America, and South America (11.1-73). The plant grows in dense clumps up to 2 meters in diameter and has leaves up to 1 meter long.

The reported life zone for lemongrass is 18 to 29 degrees centigrade with an annual precipitation of 0.7 to 4.1 meters with a soil pH of 5.0 to 5.8 (East Indian) or 4.3 to 8.4 (West Indian) (14.1-9). The plants need a warm, humid climate in full sun. They grow well in sandy soils with adequate drainage. Since the plants rarely flower or set seed, propagation is by root or plant division. The plants are harvested mechanically or by hand about four times each year with the productive populations lasting between four and eight years (14.1-9). Extensive breeding programs have developed many varieties of lemongrass.

The quality of lemongrass oil is generally determined by the content of citral, the aldehyde responsible for the lemon odor. Some other constituents of the essential oils are -terpineol, myrcene, citronellol, methyl heptenone, dipentene, geraniol, limonene, nerol, and farnesol (14.1-9). West Indian oil differs from East Indian oil in that it is less soluble in 70 percent alcohol and has a slightly lower citral content (14.1-9).

Lemongrass is used in herbal teas and other nonalcoholic beverages in baked goods, and in confections. Oil from lemongrass is widely used as a fragrance in perfumes and cosmetics, such as soaps and creams. Citral, extracted from the oil, is used in flavoring soft drinks in scenting soaps and detergents, as a fragrance in perfumes and cosmetics, and as a mask for disagreeable odors in several industrial products. Citral is also used in the synthesis of ionones used in perfumes and cosmetics (11.1-73, 14.1-9).

As a medicinal plant, lemongrass has been considered a carminative and insect repellent. West Indian lemongrass is reported to have antimicrobial activity (1.8-84, 1.8-130). Oil of West Indian lemongrass acts as a central nervous system depressant (7.6-187). Oil of East Indian lemongrass has antifungal activity (1.8-132). The volatile oils may also have some pesticide and mutagenic activities (11.1-96, 11.1-136).

Cymbopogon nardus is a source of citronella oil. *Cymbopogon martinii* is reportedly toxic to fungi (1.8-53).

Lemongrass is generally recognized as safe for human consumption as a plant extract/essential oil (21 CFR section 182.20 [1982]).

[Note: References listed above in parentheses can be found in full in the original reference].

Aromatic and Medicinal Plants Index | Purdue Guide to Medicinal and Aromatic Plants

Last modified 6-Dec-1997

Agricultural Research Service

Dr. Duke's Phytochemical and Ethnobotanical Databases

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Specific Queries of the Phytochemical Database

[Queries indicated in green new queries that search the most recent version of the database]

Plant Searches

Chemicals and activities in a particular plant.

High concentration chemicals.

Chemicals with one activity.

Ethnobotanical uses.

List chemicals and activities for a plant.

Chemical Searches

Plants with a chosen chemical.

Activities of a chosen chemical.

List activities and plants for a chemical.

Activity Searches

Plants with a specific activity.

Search for plants with several activities.

Chemicals with a specific activity.

Lethal dose (LD) information for a chemical.

Search for plants/chemicals with one or more activities.

Search for plants/chemicals with a superactivity.

Ethnobotany Searches

Ethnobotanical uses for a particular plant.

Plants with a particular ethnobotanical use.

Database References

Reference citations.

Browsable databases:

EcoSys	Plant ecological ranges	AceBrowser WebAce
EthnobotDB	Worldwide plant uses	AceBrowser WebAce
FoodplantDB	Native American food plants	AceBrowser WebAce
MPNADB	Medicinal plants of Native America	AceBrowser WebAce
PhytochemDB	Plant chemicals	AceBrowser WebAce

Documents

Dictionaries

Tico Ethnobotanical Dictionary.

Mini-Courses

Syllabus for Medical Botany Course taught by Jim Duke.

Other Databases of Interest

Taxonomic Databases

USDA Germplasm Resources Information Network (GRIN)

Medicinal and Poisonous Plants

U. Maryland

Moerman Database - U. Michigan

American Indian Ethnobotany Database

Plants and Cancer Treatments - U. Indiana

Cyberbotanica

Nutritional Databases

USDA Food and Nutrition Information Center

- USDA - NCI Carotenoid Database
- Food Composition Data

Med Access Nutrition Database

- Nutrition Analysis Tool v1.1

Reference Database

AGRICOLA--plant genetics subset [query | about]

Other Links of Interest

The Cancer Chronicles

Serious Consideration of Alternative Ideas

Phytopharmacognacy

Phytochemistry and Pharmacognosy Research Group at Middlesex University

Non Timber Forest Products

.

WARNING

Send comments or suggestions on the content of these pages to:

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8210 Murphy Road
Fulton, MD 20759

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TOP STORIES

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Cluster Busters

Supercomputer Seeks Comeback

Vector supercomputers, the original giant machines for massive computing tasks, have largely been replaced in recent years by cheaper cluster models. But the vector's maker and many researchers want a comeback. By Nancy Gohring.

Computer Maker in an Alien World

A company that makes odd-looking computers for gamers wants to expand its market. But Alienware execs wonder how many customers will appreciate the glowing alien eyes and other flourishes that have become its signature. By Michelle Delio.

When Viruses Attack

Med-Tech » A bacteria-eating virus is the star of a new video that could help researchers learn the secrets of viral infection and thereby develop better gene therapies. By Kristen Philipkoski.

A Celebration of Cell-Phone Film

Filmmakers who make tiny movies now have a festival. An independent studio is collecting entries of films made for the small screen -- the cell phone. By Daniel Terdiman.

U.K.: No Global Stem-Cell Ban

Science: In Brief » British scientists urge the United Nations not to ban stem-cell research as part of an anti-cloning treaty. **Also:** Scientists say some chocolate is good for your health…. China launches a mapping satellite…. and more.

Pulling the PBA Out of the Gutter

Rob Glaser and his geek pals from Microsoft wanted to revive pro bowling. So they bought the whole damned league. By Tom McNichol from Wired magazine.

Mini Supercomputers, Power Misers

Using low-power chips, parallel processing and innovative architecture, Orion Multisystems introduces personal supercomputers that can plug into a wall socket.

Homemade Sat Radio Software Bump

A Canadian programmer who subscribes to satellite radio writes a little piece of software allowing him to record shows directly onto his PC. Then he sells the program to others. Now the RIAA and XM Radio are busy figuring out how to bust him for it.

In Case You Missed It

Broadcast Treaty Battle Rages On

Aug. 28, 2004 Negotiation is nearing its final stage for an international treaty that would give broadcasters control over who records or transmits their signal. Broadcasters back the treaty, but digital rights advocates worry it could set an ominous precedent. By Wendy Grossman.

Secure Flight Gets Wary Welcome

Aug. 27, 2004 Air travelers face a new screening process before they step on a plane, Secure Flight. Civil liberties advocates say it's better than CAPPS II, but aren't completely sold yet. By Ryan Singel.

All That Secrecy Is Expensive

Aug. 27, 2004 Not only is the U.S. government keeping too many secrets, it's spending too much money to do it. That's the conclusion of a government watchdog group, which estimates more than $6.5 billion was spent last year keeping data under wraps. By Noah Shachtman.

Loser Delivers Laughs

Aug. 27, 2004 Don't be fooled by the title. Dear Valued Customer, You Are a Loser is not just hilarious. The book also brings up an interesting question about the relationship between humans and technology. A review by Amit Asaravala.

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Small Critters Aid in State Bioterror Monitoring The Seattle Times

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Secret of the Mummy's Tomb USA Today

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Network With No Strings Attached latimes.com (registration required)

Reining in Technology SFGate.com

E-Mail About to Be Less Private Herald Sun

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Crying Out When a Child Cannot The New York Times (registration required)

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Headless Body in Topless Car

An Atlanta man is facing vehicluar homicide and drunk driving charges after his truck hit a curb near a telephone pole early Sunday, decapitating his passenger who had been partially out of the window when the accident occurred. John Hutcherson, 21, was covered in blood and visibly drunk when police arrested him in his bed after a neighbor reported seeing a headless body dangling from Hutcherson's truck. Police found the head of 23-year-old Francis Brohm at the accident scene. Brohm was apparently decapitated by a guide wire running from the telephone. "Alcohol is believed to be the contributing factor," police said.
-- *Tony Long*

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"Governments use simulation programs to train soldiers now, and simulations really are just computer games."

A computer maker for hard-core gamer geeks is courting new customers -- the U.S. government is a likely target.

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- Water
- Yoga

Neem: A Tree for Solving Global Problems

The people of India have long revered the neem tree (Azadirachta indica). For centuries, millions have cleaned their teeth with neem twigs, smeared skin disorders with neem-leaf juice, taken neem tea as a tonic, and placed neem leaves in their beds, books, grain bins, cupboards, and closets to keep away troublesome bugs. The tree has relieved so many different pains, fevers, infections, and other complaints that it has been called "the village pharmacy."

The neem tree (Azadirachta indica) is a tropical evergreen related to mahogany. Native to east India and Burma, it grows in much of southeast Asia and west Africa. A few trees have recently been planted in the Caribbean and several Central American countries.

Outdoors, in locations where temperatures don't drop much below freezing, it may reach up to 50 feet tall. It will grow where rainfall is as little as 18 inches per year and thrives in areas that experience extreme heat of up to 120 degrees F. They are reported to live for up to 200 years.

To those millions in India neem has miraculous powers, and now scientists around the world are beginning to think they may be right.

Two decades of research have revealed promising results in so many disciplines that this obscure species may be of enormous benefit to countries both poor and rich. Even some of the most cautious researchers are saying that "neem deserves to be called a wonder plant."

In particular, neem may be the harbinger of a new generation of "soft" pesticides that will allow people to protect crops in benign ways.

Although apparently justified by the evidence, the rising enthusiasm is based largely on exploratory investigations rather than controlled experiments or the widespread use of neem products in modern practice. The results have seldom, if ever, been subjected to the rigors of independent evaluation or use. Once that happens, everything may change.

Despite all the uncertainties, however, the possibilities are indeed intriguing. This website, a composite of the visions of various researchers involved with neem, shows why.

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Health

Peppermint oil hits mosquito breeding

Peppermint oil may protect against mosquito bites

An extract of a common herb is being touted as a cheap alternative to existing pesticides in the war against mosquito-borne disease.

Peppermint oil is recommended by fans of alternative medicine to ease symptoms like indigestion, nausea and even to treat colds and flu, reports New Scientist magazine.

However, research by malaria experts suggest that the herb extract can not only repel adult mosquitoes, but kill their larvae before they even hatch.

Some experts say that peppermint oil could become a low-cost and more environmentally sensitive solution to eradicate the insects that carry potentially dangerous diseases such as malaria, filariasis, dengue fever and West Nile virus.

The team from the Malaria Research Centre in Delhi, India, extracted the oil from locally-grown peppermint, then tested it on the larvae of three mosquito species by spreading it in a film on water supplies.

Once the concentration had reached three millilitres per square metre of water, between 85% and 100% of the larvae died within a day, depending on their species.

In addition, volunteers doused in the oil were offered up as

Health Contents

- Background Briefings
- Medical notes

Relevant Stories

10 Sep 99 | Health
Irrigation 'increases malaria rates'

04 Jun 99 | Health
Doctors urge two-pronged attack on malaria

29 Mar 99 | Health
Malaria outbreak at UK hospital

Internet Links

World Health Organisation

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Alternative medicine - peppermint oil

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Disability in depth

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Antibiotics: A fading wonder

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NHS reforms: A guide

bait for mosquitoes, and found to be 85% protected.

The oil was particularly effective against *Anopheles culicifacies* which is responsible for approximately three-quarters of malaria transmitted in northern India.

Too much peppermint needed

However, a London expert expressed doubt whether their findings could ever translate into a viable pesticide, as, at this dosage, the amount of plant required would be enormous to cover even a small area.

Far lower amounts of existing commercial pesticides would be required, said Christopher Curtis, from the London School of Hygeine and Tropical Medicine.

He said: "You would need tonnes of leaves to treat all the breeding sites around a village."

Malaria is still one of the world's biggest killers, responsible or partly responsible for as many as 2.7 million deaths each year, 90% of which are in tropical Africa.

It is caused by a parasitic organism called plasmodium which is passed on when an infected mosquito bites a human.

Although there are both preventative and curative medicines for the illness, malaria control programmes also focus on the treatment with insecticide of the habitats of malarial mosquitoes close to human settlements.

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Catnip Repels Mosquitoes More Effectively Than DEET

CHICAGO, August 27 — Researchers report that nepetalactone, the essential oil in catnip that gives the plant its characteristic odor, is about ten times more effective at repelling mosquitoes than DEET — the compound used in most commercial insect repellents.

The finding was reported today at the 222nd national meeting of the American Chemical Society, the world's largest scientific society, by the same Iowa State University research group that two years ago discovered that catnip also repels cockroaches.

What's Related
Cockroaches Beware! This House Has Been Treated With Catnip
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Entomologist Chris Peterson, Ph.D., with Joel Coats, Ph.D., chair of the university's entomology department, led the effort to test catnip's ability to repel mosquitoes. Peterson, a former post-doctoral research associate at the school, is now with the U.S. Department of Agriculture Forest Service, Wood Products Insects Research Unit, in Starkville, Miss.

While they used so-called yellow fever mosquitoes (Aedes aegypti) — one of several species of mosquitoes found in the United States — Peterson says catnip should work against all types of mosquitoes.

Aedes aegypti, which can carry the yellow fever virus from one host to another, is found in most parts of the United States. Yellow fever itself, however, only occurs in Africa and South America, according to the Centers for Disease Control. Vaccines and mosquito control programs have essentially wiped out the disease in the United States, although there have been isolated reports of unvaccinated travelers returning with the disease. The last reported outbreak in this country was in 1905.

Peterson put groups of 20 mosquitoes in a two-foot glass tube, half of which was treated with nepetalactone. After 10 minutes, only an average of 20 percent — about four mosquitoes — remained on the side of the tube treated with a high dose (1.0 percent) of the oil. In the low-dose test (0.1 percent) with nepetalactone, an average of 25 percent — five mosquitoes — stayed on the treated side. The same

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tests with DEET (diethyl-m-toluamide) resulted in approximately 40 percent to 45 percent — eight-nine mosquitoes — remaining on the treated side.

In the laboratory, repellency is measured on a scale ranging from +100 percent, considered highly repellent, to –100 percent, considered a strong attractant. A compound with a +100 percent repellency rating would repel all mosquitoes, while –100 percent would attract them all. A rating of zero means half of the insects would stay on the treated side and half on the untreated side. In Peterson's tests, catnip ranged from +49 percent to +59 percent at high doses, and +39 percent to +53 percent at low doses. By comparison, at the same doses, DEET's repellency was only about +10 percent in this bioassay, he notes.

Peterson says nepetalactone is about 10 times more effective than DEET because it takes about one-tenth as much nepetalactone as DEET to have the same effect. Most commercial insect repellents contain about 5 percent to 25 percent DEET. Presumably, much less catnip oil would be needed in a formulation to have the same level of repellency as a DEET-based repellent.

Why catnip repels mosquitoes is still a mystery, says Peterson. "It might simply be acting as an irritant or they don't like the smell. But nobody really knows why insect repellents work."

No animal or human tests are yet scheduled for nepetalactone, although Peterson is hopeful that will take place in the future.

If subsequent testing shows nepetalactone is safe for people, Peterson thinks it would not be too difficult to commercialize it as an insect repellent. Extracting nepetalactone oil from catnip is fairly easily, he says. "Any high school science lab would have the equipment to distill this, and on the industrial scale it's quite easy."

Catnip is a perennial herb belonging to the mint family and grows wild in most parts of the United States, although it also is cultivated for commercial use. Catnip is native to Europe and was introduced to this country in the late 18th century. It is primarily known for the stimulating effect it has on cats, although some people use the leaves in tea, as a meat tenderizer and even as a folk treatment for fevers, colds, cramps and migraines.

A patent application for the use of catnip compounds as insect repellents was submitted last year by the Iowa State University Research Foundation. Funding for the research was from the Iowa Agriculture Experiment Station.

Chris Peterson, Ph.D., is a former post-doctoral research associate at Iowa State University in Ames, Iowa, and is now a Research Entomologist with the U.S. Department of Agriculture Forest Service, Wood Products Insect Research Service, in Starkville, Miss.

Joel R. Coats, Ph.D., is professor of entomology and toxicology and Chair of the Department of Entomology at Iowa State University in Ames, Iowa.

This story has been adapted from a news release issued by American Chemical Society.

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- Jul 06 - Natural Animal Herbal Shampoo & Dip
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- Jul 01 - Bird-Shock Flex-Track

- Mosquito Dunks & Granules
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- Sluggo Slug and Snail Bait
- Soldier Bug Attractor
- Oak Stump Yellowjacket Trap
- Barley Straw Pond Treatment
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About Biocontrol Network - Who, What, How and When.

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Rachel Carson, Silent Spring

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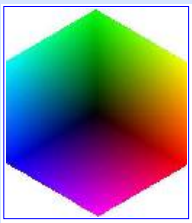

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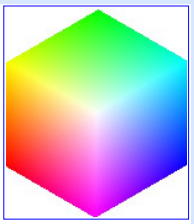

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The Rio Declaration on Environment and Development

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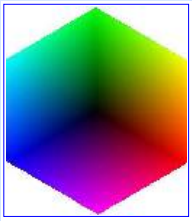

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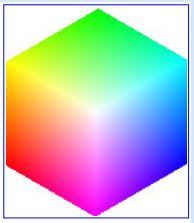

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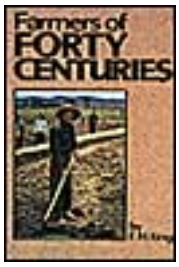

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Soil And Health Library

Health begins in the soil; Healing begins with hygiene; Liberty begins with freedom.

This is a free public library offering full-text books about holistic agriculture, holistic health, self-sufficient homestead living, and personal development. Most of the titles in this library are out of print. Some of these books can be quite hard to find; many of them are old enough to be public domain materials. The library also offers a collection about why globalised society is resistant to changing its food and health systems.

The titles in this library, when comprehended as an inter-related whole, constitute a self-guided course of study or curriculum that connects agricultural methods to the consequent health of animals and humans, shows how to prevent and heal disease and increase longevity.

The Australian-US "Free" Trade Agreement Has Passed
(17 August, 2004)

On 1 January, 2005, Australia's rules regarding when books fall into the public domain will be harmonised with the American/EU rules, making Australia a "life + 70 country". This change, when effective, will force this library to cease to offer Weston Price's *Nutrition and Physical Degeneration*, as well as a few other titles that are now public domain in Australia. As closely as it is possible to discern at this point there will be no other changes in Australian rules concerning supplying copies of out of print books to library patrons.

The Soil and Health Library has four major sections and a clipfile:

Radical Agriculture. Here, the underlying theme is how to create physical health through nutrition. This section's interest is far wider than organic gardening and farming; other health-determined approaches to food-raising are also included. Go to the **Agriculture Library**

The Restoration and Maintenance of Health. Here, the focus is nutritional medicine, primarily on methods that maintain health with proper diet and heal illness by limiting or reducing nutrition. There are also selections concerning longevity and nutritional anthropology. Go to the **Health Library**

Achieving Personal Sovereignty. Physical, mental, and spiritual health are interlinked--holistic. This collection focuses on liberating achievements, especially homesteading and the skills it takes to do that: small-scale entrepreneuring, financial independence, frugality, and voluntary simplicity. There is also a collection on social criticism, especially from a back-to-the-land point of view. Go to the **Personal**

Sovereignty Library

Achieving Spiritual Freedom. There are many seemingly-different self-betterment roads leading to the same place. Most spiritual seekers choose a path that aligns with their own predispositions. The books in this collection empower a person to self-determinedly handle their own development in an independent manner. Go to the **Spiritual Freedom Library.**

Clippings and Miscellaneous. Since this library's beginning patrons have sent information and URLs where interesting bits of information and viewpoints could be found. Until December, 2001 these were viewed without making permanent reference. Then it was realised that a file of these items might be well worth sharing. Here you will find articles and essays and etc. that support and enhance the information found in our book collections. **Go to the Clipping File.**

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- The Soil and Health Organisation maintains **links to other sites** that support its aims and goals.

- **Letters from patrons** of the Soil and Health Library: a sampling of positive responses received.

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  In some cases, the books are offered as PDFs. To download Adobe Acrobat Reader at no cost,

click the image.

The Purpose of Soil And Health (dot) Org

It is better to learn from the originators of a body of knowledge because those who follow in the founders' footsteps are rarely trailblazers of equivalent depth. Even when the earliest works in a field contain errors because their authors lacked some bit of data or had a fact wrong, their books still contain enormous wisdom. If nothing else, study of older books lets us discover that the conditions that prevail today aren't the way things always were—whilst on some levels, some things hardly ever change at all.

There are powerful forces on Earth obscuring the foundations of knowledge. That would be okay if there were better knowledge and wiser wisdoms coming on line to replace them. But usually the opposite is the case. As the sort of person Sir Albert Howard called "the laboratory hermit . . . someone who knows more and more about less and less" increasingly dominates ever-wider areas of scholarship, the focus of scholarship gets ever narrower, and less wise. Manipulative social, political and economic interests attempting to create new realities that suit them also have intentions to make people forget the fundamentals.

Here's an example. Despite all the recent advances of so-called "scientific" agriculture, the nutritional qualities of our basic foodstuffs have been declining during this century. That's largely because most agronomists focus on bulk yield and profitability of the crop, whilst knowing next to nothing about animal/human nutrition. However, there's a little-appreciated "law" about this area: nutritional value usually drops in direct relationship to the increase in bulk production. Or, in agriculture at any rate, "quality" seems the opposite of "quantity."

Industrial agriculture has devastated self-sufficient, independent lifestyles. Take the U.S. as an example. In 1870, something like 90 percent of all Americans lived on free-and-clear farms or in tiny villages. And in consequence, enjoyed enormously greater personal liberty than today. The current decline in personal rights in America and in Australia is NOT the result of there being more people dividing up a fixed and limited amount of total possible liberty into smaller and smaller slices. It is a consequence of financial insecurity, financial dependency and wage slavery. Persons lacking financial independence rarely possess sufficient spiritual freedom to forthrightly demand their social liberties. Similar degradation has occurred in Canada

What has happened since 1870 was this: as the industrial food system became ever more "efficient" it lowered the price of basic agricultural commodities. Consequently most country folk rejected their self-sufficient-farm birthright for a better-paying job in town, and soon became wage-enslaved. Wage slaves, like all other kinds of slaves, feel insecure and think that in order to survive they must not reveal their true feelings, must suppress themselves whilst pleasing those in authority.

The global industrial system's focus is on efficiency in all areas, including farming, but the apparent cheapness of economically-rational agriculture does not reflect a true accounting of costs. Despite the statistical increase in average lifespan, our average health and feelings of wellness have been declining. Consider as an example the large proportion of your neighbours whose mental awareness seems wrapped in fat. Americans especially are

disdained world wide for being hugely obese. Australians and Canadians are going the same way, spending ever-larger portions of their productivity on the treatment and cure of disease. This whole area of "health" care is not really a productive use of effort, but really constitutes enormous waste, pain, and suffering, whose main source, poor nutrition, is almost entirely unappreciated.

Dr. Isabelle Moser, who spent 25 years conducting a clinical practice using holistic approaches, in private conversations frequently suggested that what she termed the "constitution" of her older patients was typically much stronger than the constitution of her younger ones. Each generation got a poorer start than the one before it as each generation built the foundation of their health from foods produced on ever-more degraded soils grown ever-more "scientifically," and more and more consisting of processed, denatured fodder. (The full text of Dr. Moser's book *How And When To Be Your Own Doctor*, is in the Health Library.) (For a good discussion of the concept of "start," read Wrench's *Wheel of Health* in the Longevity Library. *See also:* Shelton's *Orthotrophy,* Chapter 36.)

Surely, it was a sage who so wisely quipped, "if they can stop you from asking the right questions, you'll never come up with the right answers." In this library you will encounter individuals who DID ask the right questions and even came up with some of the answers. Modern higher education points people's attention away from the Truth and toward an ever-increasing confusion created by too much data. In consequence, many can no longer recognise evil, even when it is in front of their eyes. This library restores the availability of key books written by amazing individuals, *books that offer major illumination to those who can already see, books that speak the truth to those who can still hear.*

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Solar cooker resources

"I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait 'til oil and coal run out before we tackle that." -- Thomas Edison

Solar Cookers International's Solar Cooking Archive

http://solarcooking.org/

The most comprehensive WWW resource on solar box cookers: general information, news, plans, solar cooking documents in English, German, Spanish, French, Italian and Portuguese and Arabic, country reports, technical reports, newsletters, the Solar Cooker Review, multimedia, photo gallery, slideshow, international directory, NGOs, manufacturers, supplies, books, mailing list discussion (with searchable archives), comprehensive list of links to other resources.

FAQ -- solar cooking in a nutshell:
http://solarcooking.org/solarcooking-faq.htm

Solar cooking documents :
http://solarcooking.org/docs.htm

Search the Solar Cooking Archive:
http://solarcooking.org/search.htm

Join the solarcooking-L Mailing List:
http://solarcooking.org/solar-l.htm

Searchable mailing-list archives:
http://groups.yahoo.com/group/solarcooking-l/

Solar Cooker Review, published two or three times a year:
http://solarcooking.org/docs.htm#newsletters

Links:
http://solarcooking.org/links.htm

"Balancing the Scales" -- speech by Bill Sperber at the Solar Box Cookers International Annual Meeting in l990 explains how solar box cookers can reduce inequities of health, environment, economics and political freedoms in the third world.
http://solarcooking.org/balance.htm

"The big adventure of a little solar cooker"

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No seeds, no food
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Project vehicles
The workhorses

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Trees and forests
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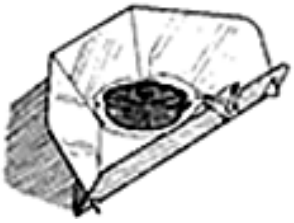
HOMeR
Eco-footprint
School and youth programs on the Web
Education resources on the Web
Children's poetry

http://solarcooking.org/bernardart1.htm
-- Roger Bernard tells how designing a cooker simple enough for 10-year-old schoolchildren to build in less than an hour led to the development of a simple solar cooker for poor rural people. The "Cookit" Foldable Family Panel cooker is neither a "solar oven" nor "curved concentrator" but a simple yet powerful hybrid. Full plans and instructions at:

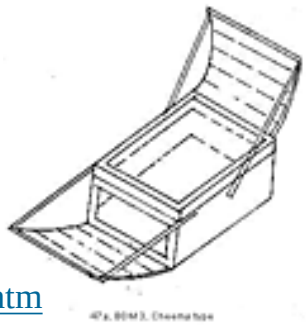


http://solarcooking.org/cookit.htm
How the "Cookit" is helping refugees in Kenya:
http://solarcooking.org/95sep15a.htm

"Understanding Solar Cookers and Ovens" by Thomas Bowman, Understanding Technology Series, Technical Paper # 36, Volunteers in Technical Assistance (VITA), 1985 -- Useful overview of the pros and cons of the different types of solar cookers available, from Professor Bowman, Head of the Mechanical Engineering Department at the Florida Institute of Technology, and a VITA volunteer. He points out that, though solar cookers were often resisted by traditional communites in the past, simply because they weren't used to them, these days they often don't have much choice in the matter because the supplies of traditional fuel have run out.
http://www.vita.org/publications/technology.htm

In **"Reduction of tropical deforestation by massive use of solar cookers"** Ari Lampinen of Technology for Life, Finland, explains why the world needs 200 million solar box cookers.
http://www.kaapeli.fi/~tep/keitin4e.html

Review of solar cooker designs by Ashok Kundapur: 56 major designs, 59 variations and 66 drawings of solar cookers. Test data by other researchers, a new set of parameters for testing solar cookers, reflectors, and insulating material.
http://members.tripod.com/~ashokk_3/solar1.htm



"Solar cookers as a means for reducing deforestation in Nepal" by Anita Manandhar of the Centre for Rural Technology in Nepal, where fuelwood demand has increased to twice the forest growth.
http://www.kaapeli.fi/~tep/crt.html

Nepal's **Centre for Rural Technology** (CRT) is an autonomous private sector, professional development organization established in

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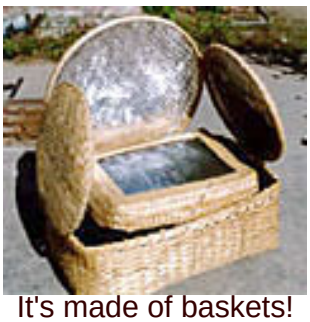

It's made of baskets!

August 1989, engaged in developing and promoting effective technologies to meet the basic needs of rural people.
http://www.panasia.org.sg/nepalnet/crt/crthome.htm

"Breakthrough in Kenyan Refugee Camps" reports on Solar Cookers International's work in Kenya. "More than 5,000 families have attended workshops and returned home with their own solar cooker. It costs only US$10 to supply each of these families with a solar cooker, a black pot, a supply of trial food, and instruction on how to use their new cooker. Follow-up visits have revealed a high level of use."

http://solarcooking.org/kakuma-m.htm

"Solar Cookers and Social Classes in Southern Africa" by William Noble Grundy -- interesting examination of the failure of a solar box cooker project in Lesotho, Southern Africa: "Several projects have already targeted the people who need solar box cookers the most, the rural women. Those projects have failed for complex reasons involving the resistance of traditional cultures to invasion by foreign innovation."
http://www.stanford.edu/group/STS/techne2.html

"Cooking with the sun: Chilean village's experiment with solar ovens offers alternative to widespread deforestation", San Francisco Chronicle, July 26, 2001 -- Lucila Rojas remembers the days when she and her neighbors risked their lives to cook a hot meal over a wood-burning stove. "We had to steal firewood, because there was no longer any left in the places where you could freely look," she said. "Sometimes we were chased (by landowners), even by gunshots. I was fed up. I didn't want any more war." Now she has a solar oven in her home.
http://www.sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2001/07/26/MN33373.DTL

Water pasteurization

"A summary of water pasteurization techniques" by Dale Andreatta. "UNICEF estimates that 60% of rural families and 23% of urban families in developing countries are without safe water. Contrary to what many people believe, it is not necessary to boil water to make it safe to drink... Heating water to 65 deg C (149 deg F) for 6 minutes, or to a higher temperature for a shorter time, will

kill all germs, viruses, and parasites" -- this is well within the range of solar box cookers.
http://solarcooking.org/solarwat.htm

"Recent Advances in Solar Water Pasteurization" by Dr. Robert Metcalf. "During the cholera outbreak in Peru, the Ministry of Health urged all residents to boil drinking water for 10 minutes. The cost of doing this would amount to 29% of the average poor household income," writes Dr Metcalf. "As a microbiologist, I have always been perplexed as to why boiling is recommended, when this is heat far in excess of that which is necessary to kill infectious microbes in water."
http://solarcooking.org/metcalf.htm

The **Water Pasteurization Indicator** (WAPI) is a polycarbonate tube containing a soybean fat which melts at 69 deg C, placed inside a water container in a solar cooker to indicate when the water has been pasteurized. Reusable. Order from Solar Cookers International, $5:
http://solarcooking.org/sci_orderform.htm
Another pasteurization indicator is based on expansion of a bi-metal disc housed in a plastic container. A mixture of beeswax and carnauba wax can also be used to indicate temperature, with a melting temperature of 70-75 deg C. Write to webmaster@solarcooking.org for details.

How to make solar box cookers

Plans and pictures of many different types of solar cookers:
http://solarcooking.org/plans.htm

Construction plans for Roger Bernard's improved **"Cookit"** Foldable Family Panel -- as used at the Kakuma refugee project in Kenya.
http://solarcooking.org/cookit.htm

The **"Minimum"** Solar Box Cooker: a powerful solar oven you can build from two cardboard boxes in a few hours.
http://solarcooking.org/minimum.htm

The **"Easy Lid"** Cooker: designs for box cookers have grown simpler, but fitting a lid can still be difficult and time consuming. In this version, a lid is formed automatically from the outer box.

http://solarcooking.org/easylid.htm

"Principles of Solar Cooker Design" by Mark Aalfs of Solar Cookers International (in two parts) -- summarizes the basic principles used in the design of solar box cookers. Heat Principles, Materials Requirements, Design and Proportion, Solar Box Cooker Operation, Cultural Factors.
http://solarcooking.org/sbcdes.htm
http://solarcooking.org/sbcdes2.htm#materials

Community cooker: the latest in community solar energy design, this cooker uses advanced parabolic technology for large-scale and multi-purpose indoor cooking without using fuels or generating smoke. In India the cooker has been developed and promoted by Eco Center ICNEER -- the International Center for Networking, Ecology, Education and Reintegration.
http://www.columbia.edu/~pgh9/solar.htm

"Designing and building home made focusing solar cookers" by Hannu Virtanen -- a complete guide to making parabolic cookers using locally available materials.
http://www.jyu.fi/~hvirtane/cooker/

Other resources

Home Power magazine is the premier publication on home-scale renewable energy and solar power -- current issue, files and downloads, educational resources, two sets of Web resources: Renewable Energy (RE) sites links, and Other links, and products: Solar2, Solar3, and Solar4 CD-ROMs, books, videos, back issues.
http://www.homepower.com

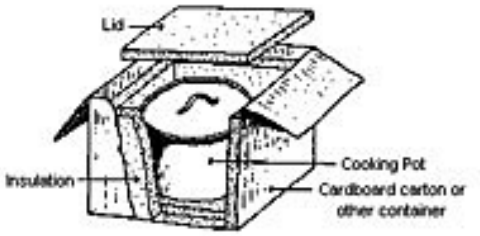
Solar cooker in Nepal: cost $3

Solar Cooking at Home Power magazine's download page:
http://www.homepower.com/download2.htm
"Solar Cook-off rules and plans for building the winners", from Issues 37 and 40 (in Adobe Acrobat format).
http://www.humboldt1.com/~michael.welch/extras/solarcookers.pdf

"You can cook almost anything with the sun and a 'low tech' box cooker that you can build yourself," says low-tech guru **Doug Edwards**. "On this day the oven reached 250 F within 35 minutes. Here in California,

where I live, I have cooked a beef roast on the shortest day of the year where the outside air temp was 40F."
http://home.earthlink.net/~drduggee/solar.htm

Links to solar cooking resources and other good low-tech stuff.
http://home.earthlink.net/~drduggee/links.htm



Haybox Cookery -- What is a haybox? Simply an insulated box used for slow cooking. Haybox cookery saves energy. Hayboxes and solar box cookers go very well together. This tipsheet from the Centre for Alternative Technology shows you how to make one and suggests two easy recipes to start you off.
http://www.cat.org.uk/catpubs/tipsheet.tmpl?frames=[frames]&subdir=information&sku=05&title=Haybox Cookery&subtitle=

Solarflex Flexible Solar Reflector Material -- Achieves the highest known level of radiant solar reflection: 97.4%! Now you can make your own solar cooking reflector for about $15 with the toughest, best reflecting material available. From ClearDome Solar:
http://home.att.net/~cleardomesolar/solarflex.htm

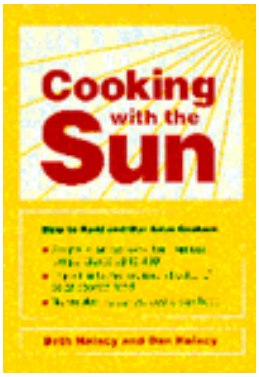
Parabola Design Wood Model -- a simple wood model is used as a tool to assure the exact parabolic shape of the mirror. Precision is very important to get a small focal sun-spot and a high cooking temperature. Details a very simple drawing tool to design a parabola, makes any parabolic curve with ease. You need two pieces of straight wood, a stiff string and a pin to make this tool and to be able to draw any parabola for a desired focal distance and size.
http://home.nexgo.de/ernst.willand/amsi-model.html
The AMSI Solar Cooker Project
http://home.nexgo.de/ernst.willand/amsi-contents.html

A Tracking Solar Concentrator for the home experimenter -- Teton Engineering Inc in the US developed a 20,000 Btu (6000 watt) solar concentrator designed specifically for the backyard mechanic to build using simple construction and basic materials. Full-text online manual -- note the disclaimers and safety warnings: "Working with solar concentrators is VERY DANGEROUS."
http://www.ida.net/users/tetonsl/solar/solarhom.htm

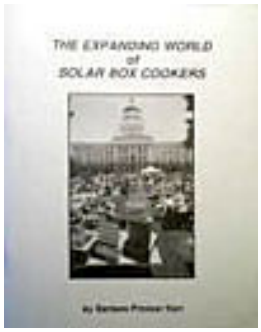
Books on Solar Cooking

"Heaven's Flame, A Guide to Solar Cookers" by Joseph Radabaugh, 144 pages, Home Power, 1991.

Complete instructions on how to build the high-performance cardboard SunStar solar cooker, discussion of other solar cooker designs, question and answer section, how solar cookers are being accepted and used around the world, detailed cooking instructions. From Home Power Magazine:
http://www.homepower.com/hflame.htm
See also "Making and using a solar cooker", article by Joseph Radabaugh in Backwoods Home Magazine, Issue 30:
http://www.backwoodshome.com/articles/radabaugh30.html
From Solar Cookers International:
http://solarcooking.org/books.htm
From Solar Energy International:
http://www.solarenergy.org/bookstore.html

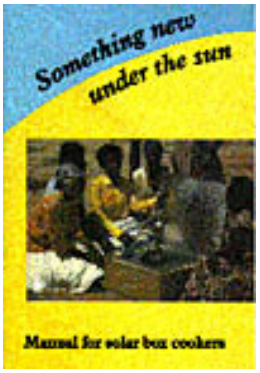


"Cooking with the Sun: How to Build and Use Solar Cookers" by Beth & Dan Halacy, 115 pages, Morning Sun Press, 1992.
Detailed plans for building a plywood multi-reflector box cooker, a cardboard single-reflector box cooker, a cardboard parabolic cooker, and a solar reflector "hot plate" cooker, with line drawings and photos, history of solar cookers, solar cooking tips and necessary cookware, 62 pages of solar recipes. From Morning Sun Press, P.O. Box 413, Lafayette, California 94549, USA, or order online from Solar Energy International Bookstore:
http://www.solarenergy.org/bookstore.html
From Solar Cookers International:
http://solarcooking.org/books.htm

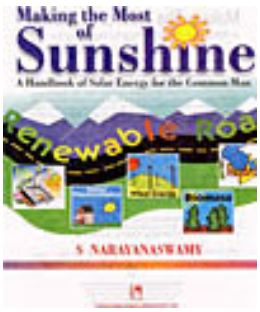


"The Expanding World of Solar Box Cookers" by Barbara Kerr, 1991.
The history and theory behind solar cooking, by one of the developers of the simple but effective cardboard solar box cooker. "Unaware that it 'should' be made of metal or wood, I used cardboard boxes and thus opened a new line of solar box cooker development" (March 1976).

With plans and instructions for building and using a solar box cooker. Online version at Solar Cooking International:
http://solarcooking.org/kerr.htm
For a printed copy, with photos and diagrams, send $15 to Kerr-Cole Solar Box Cookers, PO Box 576, Taylor, AZ 85939, USA, email bkerr@cybertrails.com



"Manual for solar box cookers -- How to build and use them" by Technology For Life, Finland, 1995 (new version 1998).
This teaching and training manual does a good job in covering the ground on the use of solar cookers. Online version:
http://www.kaapeli.fi/~tep/man/manual.html
For a paper copy of the booklet send $5 to Technology for Life, Kauppakatu 12 A 1, FIN-40100 Jyvaskyla, Finland



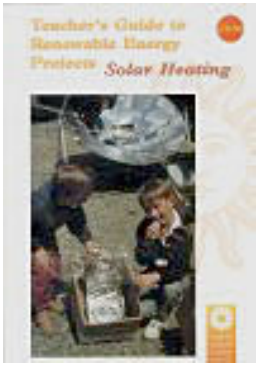
"Making the Most of Sunshine –- a Handbook of Solar Energy for the Common Man", by S. Narayanaswamy, Vikas, New Delhi.
The author's pasion for solar energy grew out of his career as a top administrator in Kerala state in India. It includes hundreds of interesting tidbits on every form of renewable energy, but two-thirds of the book deals with solar cooking. More than a dozen different solar cooker designs, along with practical sections on the best day-to-day uses of any solar cooker. The final chapter, "Promotion of Solar Cookers," compelling reading for anyone introducing solar hardware, especially in developing countries.
Email: orders@vikas.gobookshopping.com
http://www.gobookshopping.com

Solar Recipes -- Based on an original solar coobook produced by the Sacramento Municipal Utility District 10 years ago. Introduction, Cooking Guidelines, Beverages, Bread, Casseroles, Desserts, Eggs & Cheese, Meat Dishes, Pasta, Poultry, Snacks, Vegetables. Full-text online:
http://solarcooking.org/recipes/

Schools solar

"Sunlight Works -- Solar Science Educational Activities for Children" by

Heather Gurley and Bob Larson. Large-format, well-illustrated, 32-page book aimed at using solar cooking as a learning activity for children ages 8 to 12. Variety of activities illustrating solar concepts, including plans for building a solar box cooker. From: SunLightWorks, Inc., 2255 H Shelby Drive, Sedona, Arizona 86339, USA, email: blarson@sedona.net



Solar Heating: Teacher's Guide to Renewable Energy Projects, Centre for Alternative Technology (UK). This Teacher's Guide contains projects, experiments, and solar heat facts for support of a renewable energy curriculum. For grade 8 through high school. Includes solar cooker experiments, solar water heating, solar ponds, solar troughs, and other related ideas, all with how-to experiments suitable for the classroom. Solar radiation concepts are nicely explained. From PicoTurbine books http://www.picoturbine.com/booklist.htm#CAT

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Trees, soil and water
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Solar box cookers

In the modern-city environment, flipping a switch to abundant energy supplies is usually an unconscious act, with little awareness of the critical issues that lie behind it.

- electrical power is generated by fossil fuels
- fossil fuels are a scarce resource, due to run out this century -- estimates vary between 20 years' and 50 years' supply left
- fossil-fuel energy production is highly polluting and increases global warming
- in terms of the Kyoto Protocol on global warming, all countries must reduce their emissions of the greenhouse gases that cause global warming.

Modern city dwellers are privileged: most people do not even have a switch to flip.

Half the inhabitants of Earth cook over woodfires -- 45% of the world's wood is used as fuel. But there's not enough to go round: some 2.4 billion people are now facing shortages of fuelwood.

We cooked rice by the sun in a brown teapot, before we had a black cooking pot. It worked.

Meanwhile deforestation helps cause climate change, floods and soil erosion, increasing environmental degradation, and increasing poverty and hunger.

Woodsmoke from cooking fires is a major source of air-pollution and an outright killer: it causes respiratory infections which kill at least 5 million young children each year.

At the same time millions of people do not have access to clean drinking water, causing widespread disease, especially among children: the WHO says diseases spread through contaminated water cause 80% of the world's illnesses.

There's a simple answer to these problems, that can save millions of trees, provide clean, safe drinking water, doesn't smoke, and that costs just about nothing -- a cardboard box.

No seeds, no food
Appropriate technology
What works and fits
Project vehicles
The workhorses

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Internet interaction
Finding your way

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Sisters of silk
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Trees and forests
The Beach House fish pond
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Eco-footprint
School and youth programs on the Web
Education resources on the Web
Children's poetry

Most cardboad boxes end up in the garbage dump. Recycling them saves wood, saves water, prevents pollution and saves a lot of energy.

But, while recycling 60 or so cardboard boxes might save one tree, one solar box cooker can save at least one whole tree all by itself, each year:

- Research has found that 36% of firewood needs could be replaced by solar box cookers, or 500kg of wood per family per year, totalling many millions of trees.
- Solar box cookers produce no smoke, no pollution.
- Solar box cookers can pasteurize drinking water: heating water to 62.8 deg C for 20 minutes destroys disease organisms, and this temperature is easily achieved with solar box cookers.
- Solar box cookers can even be used on cloudy days.
- Solar box cookers would also save millions of women the many hours (or days!) wasted searching for firewood, giving them more time to look after their children, to grow more food, and for education -- which is the key to reducing population growth (the world's population passed six billion people in October 1999 -- every second five people are born and two people die).

Solar box cookers are easy to make -- one cooker designed to be simple enough for 10-year-olds to build without special tools in less than an hour is now helping to feed refugees in Africa (and to save trees).

Using a CookIt solar cooker, with a box cooker on the table behind. There are many types of solar cookers.

Subject areas:

- how to make a solar box cooker
- a solar cooker kids can make
- solar rice for lunch
- solar cooking recipes
- free energy
- clean water
- how solar box cookers can save the world's forests
- appropriate technology
- energy issues
- pollution and waste recycling

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Handmade Projects
Ichijima
Japan

Solar box cookers are providing answers and helping people to live better lives and protect their environment in many parts of the world.

But it's a field that's wide open for innovation and further development. There is as yet no such thing as the ideal solar box cooker. One World Wide Web site lists 56 different designs of solar cookers -- many of them good, but none of them perfect.

This is an area where schools groups can really help to make a breakthrough.

Extensive resources online, schools textbooks and videos available.

Solar box cookers
Solar cooker resources on the web

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FACT Sheet

Why Population Growth Matters to the Future of Forests

The world's forests provide goods and services essential to human and planetary well-being. But forests are disappearing faster today than ever before. Due both to deforestation and human population growth, the current ratio of forests to human beings is less thn half what it was in 1960. Yet we not only need more forests, we need forests more than ever before–to protect the world's remaining plant and animal life, to prevent flooding, to slow human-induced climate change, and to provide the paper on which education and communication still depend. More efficient consumption of forest products and eventual stabilization of human population–a prospect that appears more promising today as birthrates decline–will be needed to conserve the world's forests in the coming millennium.

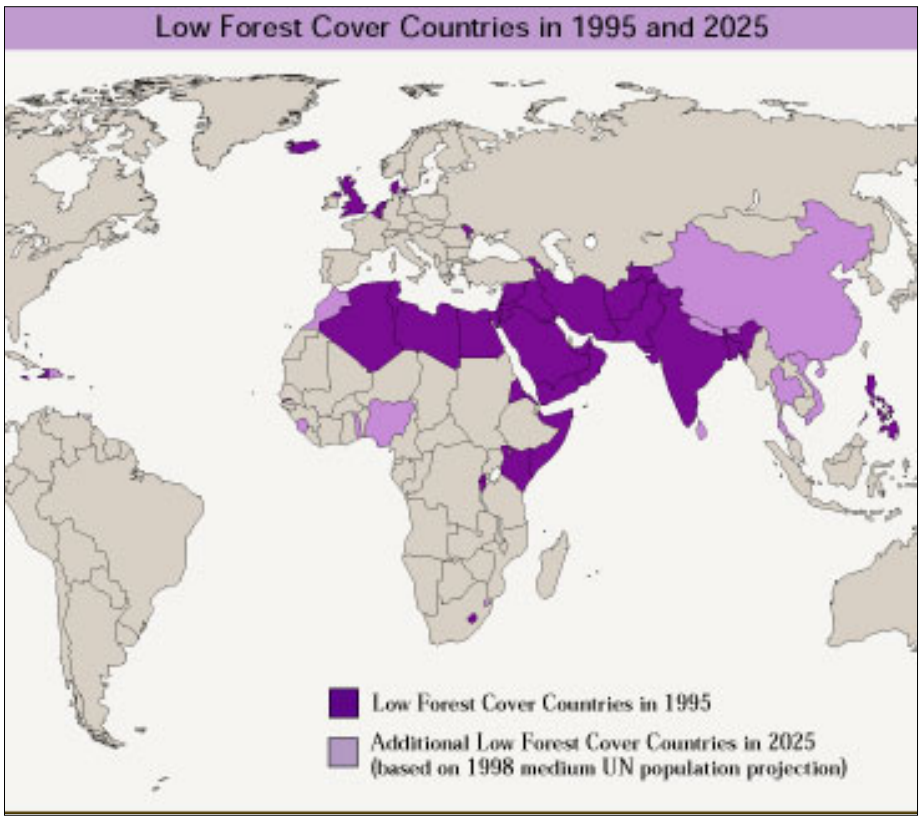
In some countries, forests and other vegetation are being burned away at alarming rates to satisfy the growing demand for agricultural land.

Forest Cover is Decreasing...

Half of the world's original forest cover is gone, a loss that reflects humanity's intensive use of land since the invention of farming. Of the forest that remains, less than one-fourth could be considered relatively undisturbed by human activity. The vast primeval forests of Europe and Asia survive today only as patchwork remnants of secondary growth, much of it vulnerable to logging, encroachment by development, pollution, fire and disease.

Forests are currently expanding in much of the industrialized world, while shrinking in most of the developing world. In just the first five years of the 1990s, 65 million hectares of forest–an area the size of Afghanistan– were converted to other uses in developing countries. By contrast, the industrialized countries gained 9 million hectares of forested land, an area

about the size of Hungary. The pattern of forest loss in developing countries today differs from past losses in Europe and elsewhere in two key respects: human populations are much larger than before, and the pace of deforestation is more rapid. In the last four decades, an area half the size of the United States has been cleared of tropical forests, while population in developing countries has doubled to 4.7 billion. Among the most encouraging trends for the future of forests is the fact that fertility and birthrates are now declining in developing countries, leading demographers to revise downward their projections of future population growth.



A new measure of forest resource availability helps illustrate the increasing scarcity of forests in many countries. The forest-to-people ratio– a simple division of a country's forest cover by its population–helps quantify the number of people living with low levels of forest resources both now and in the future. Using a ratio of 0.1 hectare of forest cover per person (roughly a quarter acre) as a benchmark reveals that 1.7 billion people now live in 40 countries with critically low levels of forest cover. Many are vulnerable to scarcities of key forest products such as timber and paper and risk the collapse of vital forest services such as control of erosion and flooding in populated areas. In some countries the forest-to-people ratio declines even though forests expand, simply because their populations grow more rapidly than their forests. By 2025, based on United Nations data on deforestation and projected population growth, the number of people living in forest-scarce countries could nearly triple to 4.6 billion. Many are unlikely to have the options of wealthy countries to import or use substitutes for forest products and the environmental services forests provide.

...As Pressures on Forests Increase

Population dynamics are among the primary underlying causes of forest decline. Poverty, corruption, inequitable access to land and wasteful consumption practices also influence the decisions of governments, corporations and individuals to cut and clear forests. The interaction of these forces is most evident in areas such as South Asia, Central America and sub-Saharan Africa, where poverty, rapid population growth and weak institutions contribute to forest loss and severe environmental degradation.

The dominant force in forest loss is growth in the demand for farmland. Subsistence agriculture is the principal cause of forest loss in Africa, Asia and much of Latin America. Slash-and-burn farming and other traditional techniques were sustainable for centuries when population densities were lower. Today they are a major factor, along with the expansion of

commercial farms and livestock grazing areas, in the permanent conversion of wooded land to agriculture. The need to increase food production is expected to accelerate the forest-to-farmland cycle, especially in countries where alternatives for meeting this demand are limited.

A typical American uses 15 times as much lumber and paper as a resident of a developing country.

Total wood consumption has tripled during the 20th century. Per capita consumption has changed little on a global basis–actually decreasing slightly–but consumption patterns vary widely between countries. A typical American uses 15 times as much lumber and paper as a resident of a developing country. Reducing wood consumption in the industrialized world is unlikely to stop forest loss in developing countries however, since most of the wood consumed comes from trees in the industrialized countries themselves. Nevertheless, the consumption model offered to the rest of the world threatens accelerated forest loss as both populations and economies grow in developing countries.

Commercial logging of tropical forests has doubled since 1960, accounting for 5 million to 6 million hectares of forest loss each year, an area nearly the size of Sri Lanka. This is about one third the forest area lost each year in the developing world. Illegal logging causes a significant, though unquantified, amount of additional forest loss. Logging's biggest role in deforestation, however, is more indirect. Logging roads provide pathways deep into forests that farmers and other settlers then follow, permanently clearing the land for crops and pasture.

Nearly 3 billion people depend on wood as their main source of energy. The production of fuelwood and charcoal accounts for over 90 percent of the wood harvested in Africa, 80 percent in Asia and 70 percent in Latin America. Population growth is closely linked to rising woodfuel demand. The effects of woodfuel scarcity are most severe in impoverished areas, where more modern fuels are inaccessible or unaffordable.

The Human Face of Forest Loss

Women and children are the victims of woodfuel scarcity. The search for fuel consumes the time, energy and health of women and their children. As local wood supplies grow scarce, women risk spinal column damage and uterine prolapse from carrying heavier loads over longer distances. Girls are often kept home from school to help their mothers gather wood, depriving them of educational opportunities. Where wood is unavailable, women cook with inefficient fuels such as animal dung or crop wastes, depriving livestock of fodder and soils of natural fertilizer. This endangers both the nutritional and respiratory health of women and their families.

Forest scarcity threatens the use of paper for education, the activity most likely to improve health and economic well-being. 80 percent of the world's population lack access to enough affordable paper and reading materials to meet basic standards for literacy and communication. Reducing paper consumption could help ensure enough paper for all. These efforts are undermined, however, by broader inequalities in access to education and economic opportunity. Closing the "paper gap" between rich and poor nations ultimately depends on government action to increase spending on education, health and social services in developing countries. Future population growth and forest loss will largely determine whether and when this gap can be closed.

Helping People, Sustaining Forests

Population policies based on human development and human rights offer the greatest hope for the future of forests. This is not an argument for population "control" but for the social investments that allow couples to choose when to have children and how many to have. Programs linking conservation activities with family planning services show promise for achieving both the sustainable use of forests and greater acceptance of reproductive health services.

Sustainable wood consumption is essential for the future of forests. Individuals and institutions alike should promote the ecologically sound and socially responsible use of forest products. Eco-labeling, or the environmental certification of wood products, could speed the adoption of more sustainable forestry practices. Consumer demand for green-certified paper and other wood products is an important complement to recycling and other efforts to reduce wood consumption.

The well-being of the world's forests is closely linked to the health and well-being of women. Investing in education for girls helps them to contribute to their national economies–and to postpone childbearing until they are ready for a family. Providing credit and other economic opportunities for women creates alternatives to early and frequent childbearing. Finally, better access to quality reproductive health services directly benefits women and their families. These approaches increase human capacity, providing the greatest long-term return to societies, individuals and the environment. Moreover, they are likely to lead to an early peak in world population in the coming century–quite possibly at levels that can co-exist with forests that teem with human and non-human life for centuries to come.

Source

Tom Gardner-Outlaw and Robert Engelman, Forest Futures: Population, Consumption and Wood Resources. Washington, DC: Population Action International, 1999.

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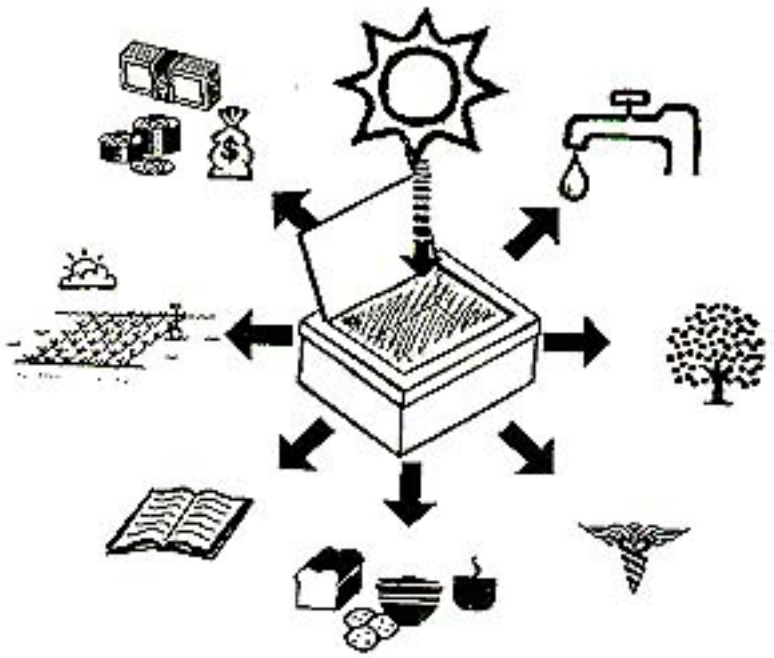
planet symbolizes the conviction that greater access to voluntary family planning benefits the health of women, children and the environment worldwide

The Solar Cooking Archive

Balancing the Scales

Reduction of inequities through the use of solar box cookers

Presented by Bill Sperber of the Pillsbury Company on April 7, l990 at the Solar Box Cookers International Annual Meeting.



Many of the world's people are confronted by staggering inequities in matters of health, environmental quality, economics and personal and political freedoms. The inequities tend to be interrelated; consequently many people are forced to live in abject poverty.

Inequities

Health: The general unavailability of health care and family planning services in the third world has exacerbated many chronic health conditions. Several billion people suffer regular bouts of diarrheal illness because of the lack of clean water. Many suffer respiratory and eye ailments because of the extremely smoky cooking conditions which are equivalent to smoking 10-20 packs of cigarettes per day. A great deal of malnutrition is caused by the lack of food, the under-cooking of food (because of the shortage of fuel) and the practice of single pot cooking which means that separate weaning foods cannot be prepared. As a result, 14 million young children die each year and the life expectancy in many countries is less than 50 years.

Environment: Unequal distribution of energy sources is causing environmental degradation in the third world. Even though the third world consumes little energy compared to the first world, 90% of its energy is used for cooking food. Already, 1/4 of humanity is affected by a fuel wood shortage; by the year 2000 the shortage will affect at least 2.4 billion people (UN/FAO estimate). The ensuing deforestation causes soil erosion, water pollution, a loss of soil fertility, and ultimately, desertification. Sub-Saharan Africa is a graphic example of this process.

Economics: Many of the third worlds people are trapped in a vicious economic cycle of poverty because of their low income and lack of land ownership. Many families are forced to spend more on cooking fuel than they are able to spend on food. Third world governments are unable to assist their poor citizens because of the high interest rates attached to their foreign debts accumulated in the past decade.

Freedoms: The poor of the world are further impoverished because of a lack of personal and political freedoms. In our terms, they endure a subhuman existence. Many people suffer at the hands of oppressive governments and are victimized by the prevailing (male) attitudes and cultural

practices. Almost universally, the poor of the world, and especially the women, are enslaved to the processes of fuel collection and cooking. Very few are literate; most receive less than a third-grade education.

Solutions

Gloomy as the above situation may seem, there is hope for the poor of the world. There must be hope, or else humanity will perish. Many of the more fortunate people in the world are developing programs and strategies to balance the scales and reduce the inequities which separate humans.

We have learned in the past 14 years that a simple cooking device, the Solar Box Cooker (SBC), can ameliorate each of the inequities cited above. SBCs can serve as a focal point to catalyze the attainment of many objectives in international development programs.

Health: The SBC can improve health in the third world in numerous ways. It can be used to pasteurize water, by heating it to 65C (150F), thereby reducing the incidence of diarrheal illnesses. The SBC is smokeless, its use will reduce the incidence of respiratory and eye ailments. It can even be used to disinfect medical instruments, as such it could be of significant benefit in many poor areas; it can even destroy the AIDS virus. Importantly, several pots of food can be cooked simultaneously, permitting separate preparation of weaning foods. All foods can be thoroughly cooked, thereby aiding digestion and enhancing nutrient absorption. Breadstuffs can be baked in an SBC, yielding foods which have some degree of stability.

Environment: Use of the SBC will reduce dependence on fuel wood and charcoal. Reduced rates of deforestation will yield reduced rates of soil erosion. In many villages there is a complete lack of fuel wood and the people have resorted to burning dried animal dung or crop residues. These practices deprive the soil of much of its potential fertility. Use of the SBC minimizes the burning of dung and crop residues, thereby permitting those materials to be used as natural fertilizers.

Economics: Much of the expense of fuel wood, charcoal or kerosene can be eliminated through the use of an SBC. The SBC also requires a low capital outlay; it can be built for about $20, an amount equivalent to one or two weeks of cooking fuel purchases. The SBC should be a useful tool to stimulate economic development in poor areas. It is ideally suited to low -technology cottage industries. Because of its relatively low cost, revolving loan funds could help spread the SBCs quickly.

Freedom: For many, the SBC is a significant labor-saving device since less time would need to be spent in accumulating and transporting fuel wood or dung. A project leader in Guatemala said, The Solar Box Cooker can liberate women from millennia of slavery. The saved time can be used for education, better family care, and food production. In turn, greater economic and political freedoms will follow.

We are living and participating in a very strange system. Humanity has one foot stepping towards the stars, while the other is mired in a sinking sea of poverty. The distance between humanity's two feet is growing. We can help reverse the process by teaching several billion people in the Third World how to build and use solar box cookers.

For questions or comments, contact
webmaster@solarcooking.org

http://solarcooking.org/balance.htm

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Cooking smoke: a pervasive killer in developing countries.

WIN News01/01/98
v24:n1. p21(1)

PEOPLE & the PLANET, 1 Woburn Walk, London WCIH 0JJ, UNITED KINGDOM. Vol.6, No.3.

"Billions of dollars have been spent on research into the harmful effects of cigarette smoke and outdoor air pollution. . . Comparatively little has been done to protect human health from indoor air pollution. Wood, stubble, dung and grass are used daily in about half of the world's households as energy for cooking and heating. In most parts of the Third World they are burnt in open fires or inefficient stoves in poorly ventilated kitchens. The result is a toll in death and iii health far greater than the more often discussed outdoor air pollution.

Biomass smoke contains many harmful constituents such as respirable particulates and carbon monoxide, exposure to which can cause or contribute to acute respiratory infections, pneumonia, tuberculosis, lower birth weights, cataract, and nervous and muscular fatigue.

Smoke, especially coal smoke, also contains sulphur and nitrogen oxides and hydrocarbons which can lead to cancer. Women and children are most exposed to high levels of harmful smoke and suffer the most serious health damage; respiratory infections alone cause between 4 and 5 million deaths per year among small children, which is equal to or marginally less than deaths from diarrhoeal diseases. . .Some 1.9 million additional deaths each year are blamed on rural indoor pollution through suspended particulate matter and another 450,000 deaths are attributed to urban indoor air pollution. . .African countries and India have the worst record. . . in rural homes, while Latin America, India and China are worst. . . in urban interiors. . . For example, several studies in China found that smoke was a strong risk factor for lung cancer among nonsmoking women, while another study in Japan has related lung cancer to the past use of biofuels in cooking.

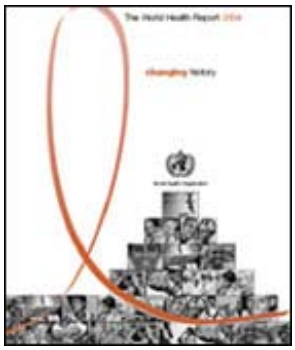
In Gambia it was found that girls aged under five carried on their mother's back during cooking (in smoky cooking huts) had a six times higher risk - a substantially higher risk factor than if their parents smoked.

SMOKELESS STOVES

Unfortunately, while the health problems are all too clear, the solutions are as many as grains of sand in the desert. The issues involved are culturally diverse since they relate to such basic traditional patterns as how people live and cook and eat. The literature abounds with designs for 'simple' smokeless stoves or 'elementary' chimneys, hoods and smoke removal appliances. But persuading people to build, install, maintain and use such devices en masse is a thorny issue; indeed the first step is probably to persuade the millions exposed to biomass smoke that it does actually pose health hazard. . ."

The world health report

The world health report 2004 - changing history



This year's report, *changing history*, calls for a comprehensive HIV/AIDS strategy that links prevention, treatment, care and long-term support. At a crucial moment in the pandemic's history, the international community has an unprecedented opportunity to alter its course and simultaneously fortify health systems for the enduring benefit of all.

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Smoke gets in their eyes

ITDG's new study and projects provide practical solutions to the problem of indoor air pollution in developing countries

Independent research indicates that indoor air pollution is a contributory cause of around two million deaths in developing countries. Acute respiratory infections, ear and eye problems, breathlessness, chest pains, headaches and giddiness are just some of the symptoms that poor woman and children suffer in their rural homes. And the cause? Smoke from cooking.

However, in a report supported by Glaxo-Wellcome and other donors, launched at DFID on January 31st 2002, ITDG highlights how its Kenya Smoke and Health Project provides a model to reduce the smoke by as much as 77%.

Around 80% of people living in sub-Saharan Africa depend on biomass - wood, dung and crop residues - for domestic energy. But burning these fuels in enclosed spaces results in indoor air pollution.

The project, involving 50 rural households in Kajiado and Western Kenya, devised appropriate technology to reduce pollution in people's kitchens. Results showed that the introduction of smoke hoods, eaves, windows and improved, fuel efficient stoves can reduce these damaging particles by approximately two thirds.

Dr Liz Bates, ITDG's Smoke and Health Project Co-ordinator elaborates: "The project identified that the levels of smoke particles in these rural homes is, in most cases, more than 100 times greater than the acceptable level of 50 micrograms of smoke particles per cubic metre suggested by the US Environmental Protection Agency."

Hellen, the field supervisor, calibrates a particulate monitor before it is taken to one of the households. (photo: N Bruce)

Readings were taken in the cooking area of each home, on two occasions before the smoke hoods were introduced, and on two occasions after the technology was installed. The cooks' exposure to carbon monoxide was measured independently.

Statistical analyses of the results show that the introduction of the hoods produced an average reduction of health-damaging particles in the house of 75% and in carbon monoxide, of 77%. The results from the cooks' personal

monitors gave an improvement in carbon monoxide exposure of 35%.

Where the households selected eaves spaces, windows and stoves, the reduction in smoke particles was 62%; and other benefits included increased daylight and more pleasant working conditions.

Stephen Gitonga, ITDG's Energy Programme Manager in Kenya, said "The project also identified that the use of smoke hoods and other forms of technology not only improved people's health, but also reduced drudgery, saved money and increased people's comfort.

"Refa, the husband of a project woman, who used to suffer from asthma attacks before the technology was put in place, told us that he used to steer clear of the kitchen before, but he is now willing to assist his wife in some domestic tasks. Nowadays he wakes up at 5.30am, puts his bathing water on the fire, then goes to bathe as he leaves the tea getting ready on the fire. His wife is now relieved from waking up early and doing all the household chores by herself."

For Refa's wife, less soot on walls, ceilings, hair, sheets, children's books and clothes makes it easier for her to wash her children, do the housework and light the fire. The interventions also help her cook faster ... and any fuel can be used with the smoke hood so the family can stay longer in the house, cook food faster and watch over their livestock through the windows.

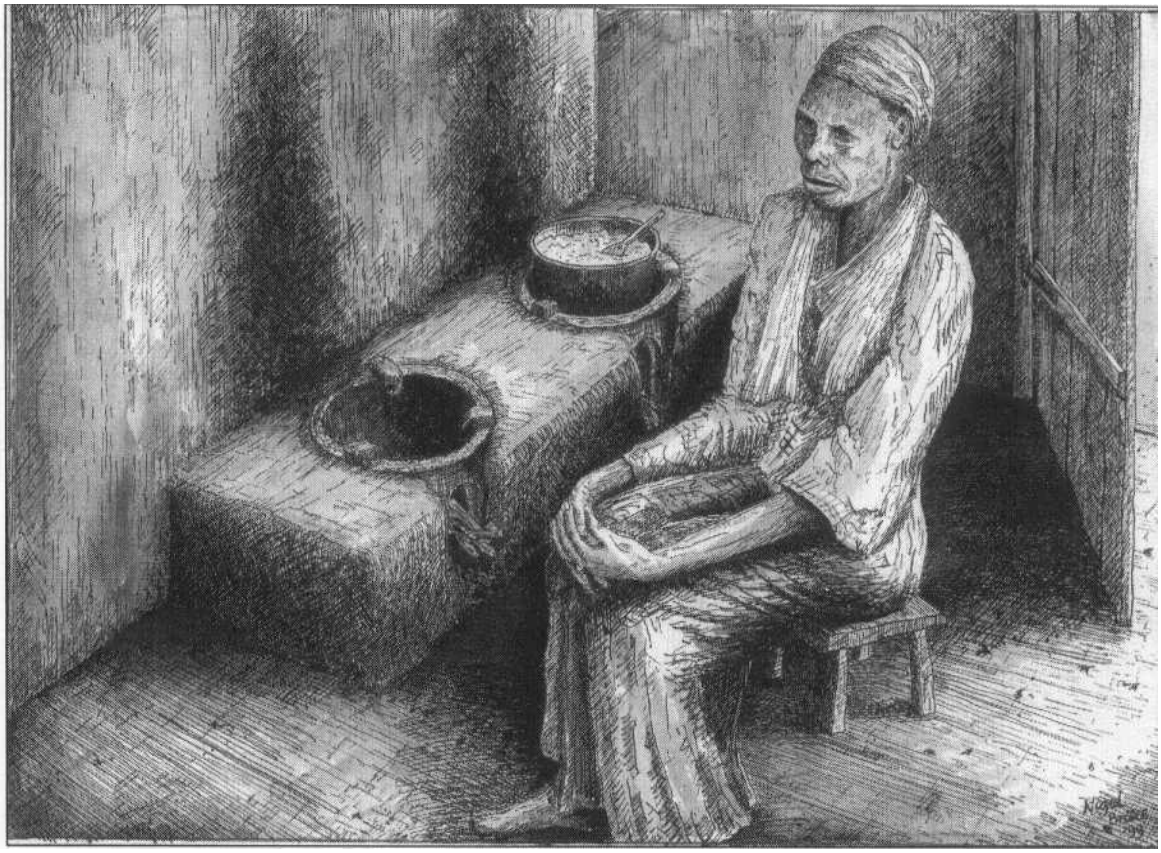
The new windows in their houses have allowed Kajiado women to do beadwork in their homes, while their children can do their homework. (photo: N Bruce)

DFID is providing funds from its Energy Knowledge and Research Budget for ITDG to disseminate lessons learnt and instigate similar work in urban Kenya, Sudan and Nepal.

Download the full report ~430Kb
or read an illustrated summary of the project ~670Kb

An illustrated version of the full report is also available. Please note that this file is over 3MB and is only suitable for broadband connections.

Read more about the Smoke and Health project on the Technology for Sustainable Livelihoods website
or find out about ITDG's other energy projects
Read more about household energy in ITDG's journal Boiling Point



Reducing indoor air pollution in rural households in Kenya:

working with communities to find solutions

ITDG project 1998-2001

January 2002

PRACTICAL ANSWERS TO POVERTY

Reducing indoor air pollution in rural households in Kenya:

working with communities to find solutions

The ITDG Smoke and Health project
1998-2001

Dedicated to the memory of Peres Atieno Olumbo a member of the project team who died tragically young following a long illness

Project team

Kenya staff
Stephen Gitonga; Justin Nyaga; Hellen Owalla; Martha Mathenge; Milka Lang'at Edward Marona Peres Olumbo (deceased); Rose Okodo; Sharon Looremeta; Simon Ireri; Tony Katampoi Lemayian; Moses Mosiany; Vincent Okello; Amina Mateu; James Letiah; Michael Kathuri ; Joseph Gitahi, Charles Ganda and John Koite

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Project statisticians
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Funded by:
GlaxoSmithKline; Veta Bailey Charitable Trust; Ajahma Charitable Trust; Emerging Markets Charity

Cover; West Kenyan woman andUpesi stove
(iillustration: Nigel Bruce)

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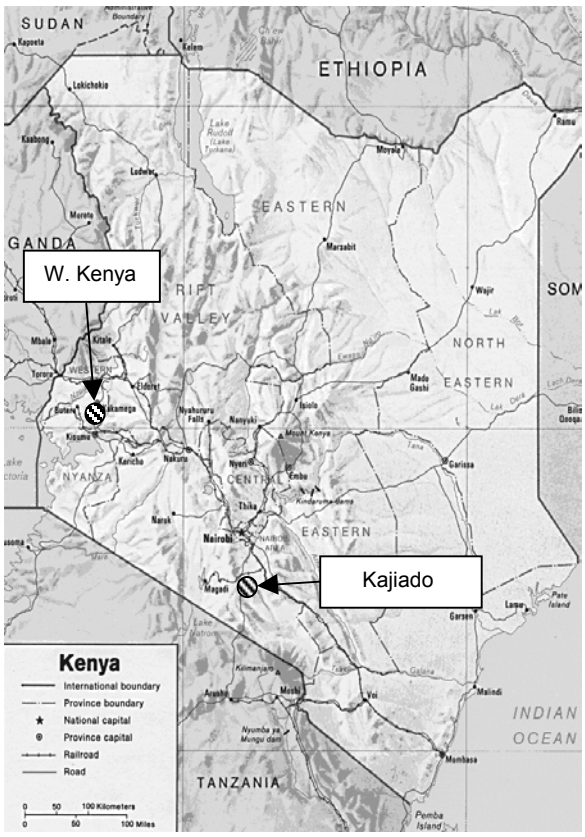
Executive summary



Around 80% of people in rural sub-Saharan Africa depend on biomass (wood, dung, crop residues) for domestic energy. There is mounting evidence that the resulting indoor air pollution (IAP) increases common, serious health problems, including childhood pneumonia and chronic lung disease. Previous attempts to reduce this have often failed due to lack of community involvement in developing appropriate, sustainable solutions.

The ITDG Smoke Project was launched on May 6,1998. The aim of the project was to contribute to the reduction of exposure to indoor air pollution in the light of these negative health effects. Working with 50 households in rural Kenyan communities, participatory technology development through participatory research methodologies enabled the project to alleviate this pollution in people's kitchens. Evaluation of changes in pollution levels and community views about the process and interventions was carried out.

Two study areas were chosen; Kajiado where ITDG is involved in the Maasai Housing Project and two communities in West Kenya where ITDG is engaged in the Stoves and Household Energy project. These two areas are totally different climatically and geographically as well as culturally (lifestyles, cooking habits and house types). Baseline monitoring in the kitchens in these areas showed that smoke levels were unacceptably high: in Kajiado, the 24-hour average of respirable particulates was 5526µg/m^3 and in West Kenya, the levels were 1713µg/m^3. If one compares these values to the EPA standards for acceptable annual levels of respirable particulates of 50µg/m3, it can be seen that the daily rates (which are comparable, in these societies to the annual rates) are over one hundred times greater in Kajiado and twenty times greater in West Kenya than the accepted values.

By involving communities in areas where ITDG is well-known and respected, participation and co-operation from people in monitoring the smoke levels of their houses was assured.

Main objectives

The main objectives of the project were twofold: to improve the quality of life, through reduction in indoor air pollution, for households in these study areas; and to develop a participatory methodology for further research into appropriate ways to alleviate indoor air pollution. These objectives were to be achieved through:

- Carrying out a baseline assessment of pollution and exposure, fuel use and house structure
- Identifying participatory ways of alleviating indoor air pollution through development and installation of interventions. (*Interventions*, within the context of this project, were identified as any changes which took place as a result of project activities which could affect the levels of indoor air pollution to which the occupants of the kitchen, especially women and children, were exposed.)
- Evaluation of changes in pollution and exposure, community views of the process used, and the acceptability and affordability of the interventions
- Empowerment of communities by making them aware of the risks associated with household smoke and enabling mechanisms for its alleviation
- Development of a strategy in a national context for dissemination and sustainability within the market constraints of the communities

- Exchanging experience internationally to strengthen Kenyan work and to contribute to implementation of best practice in other countries
- Development of a replicable participatory methodology on appropriate methods for reducing indoor air pollution. This methodology will form the basis for future work in international studies on indoor air pollution and interventions.

Key methods adopted in project

The participatory methods described in this publication, combined with technical monitoring, allowed the project to identify interventions that are both *appropriate* and *effective* in reducing indoor air pollution. Some key aspects include:

- The involvement of households throughout the project
- Finding out those factors associated with smoke which the community members themselves found most problematic
- Knowledge sharing on the dangers of smoke so that people in the community are empowered to take action
- Local teams being open to ideas and suggestions from the community on ways to modify interventions to benefit the households
- Installation of interventions in collaboration with the household members
- Monitoring, to find out which interventions were really effective in removing smoke
- Monitoring both the kitchen and the cook so that the inter-relationship between the levels in the kitchen and the levels she inhales can be assessed
- After interventions had been installed, learning the preferred options from the community.

Participatory development

Common themes and principles in participatory development (PTD) practice include:

- That the community is the main actor in any development initiative
- That the outsider's role is basically supportive to the local efforts
- That the development activities should be oriented towards needs as perceived by the community
- That indigenous knowledge has an important role to play as a basis for action, support and strengthening
- That the key challenge is to tap the potential interaction between indigenous knowledge and that of outsiders.

Activities

- Research study completed in 50 households in West Kenya and Kajiado.
- Awareness created in all selected households.
- Interventions installed in 50 houses in both West Kenya and Kajiado.
- Reduction in indoor air pollution levels – respirable particulates (PM_{resp}) and carbon monoxide (CO)
- Benefits of appropriate interventions discussed with households.
- Eight artisans trained on fabrication and installation of technical intervention in two regions.
- Women trained on operations and maintenance of the interventions.
- Focus group discussions held with the communities that promoted participatory interactive communications on health related issues of their families.
- Dissemination of knowledge through various media: publications, video, conferences

Key impacts

Reducing smoke

The primary concern of the project was to reduce indoor air pollution. There were substantial reductions in the particulate matter and carbon monoxide levels in the sample households after the interventions were installed. Table 0.1 gives the overall results – the statistical significance of these results will be detailed later in this report.

Table 0.1 Overview of reductions in particulates and carbon monoxide resulting from installation of interventions			
Reduction in particulates (%) – *(statistically significant results in bold)*			
	Kajiado	**West Kenya (4ft)**	**Combined**
All interventions	**36%**	**63%**	**43%**
Smoke hoods	**76%**	**70%**	**75%**
Eaves spaces		60% (average)	
Windows		**No observable change**	
Stoves	Not adopted	**54%**	
Reduction in room carbon monoxide (%)			
	Kajiado	**West Kenya (4ft)**	**Combined**
All interventions	**31%**	**53%**	**34%**
Smoke hoods	**77%**	74%	**78%**
Eaves spaces		28% (average)	
Windows		**No observable change**	
Stoves	Not adopted	42%	
Reduction in carbon monoxide inhaled by cook (%)			
	Kajiado	**West Kenya (4ft)**	**Combined**
All interventions	6%	32%	16%
Smoke hoods	28%	59%	35%
Eaves spaces	Not adopted widely	56% (average)	
Windows		**No observable change**	
Stoves	Not adopted	5%	

Poverty impacts

The project has seen the project households accrue socio-economic, health, and cost benefits as a result of project activities and interventions. Whilst maintaining cultural requirements of housing design, the project has made improvements in ventilation, natural lighting, maintenance and general comfort in these households.

- Substantial reductions in indoor air pollution will have a positive impact on the health of the community
- Provision of more time to engage in economic activities through using stoves, rather than three-stone fires
- Increased income through manufacture of smoke hoods, stoves, windows & frames for eaves spaces
- Savings realised through reduction in use of kerosene lamps and burning fuel more efficiently in stoves
- The community noted a reduction in time and money spent in hospitals with burns, coughs, eye, and chest pains
- Improved status of project women within community
- Women have gained confidence through the participatory activities
- Project team empowered with skills in data handling and analysis
- Reduction in fuel consumption through stove use with consequent reduction in pressures on biomass sources

Negative Impacts

- Houses are now cooler and experience more draughts due to openings in the houses – this is a negative impact during cold and wet weather
- Some cultural concerns about lack of privacy and security
- In West Kenya, where there was a cost-sharing element, this proved difficult for some households
- Difficulties with wick lamps when it is windy and the window is open

Chapter 1 – The relationship between health and household energy

Introduction

It is currently estimated that around two-thirds of all households in the developing countries still rely primarily on unprocessed biomass fuels (wood, dung, crop residues) for their daily cooking and heating needs (World Resources Institute 1998); this includes around 80% of all people in rural sub-Saharan Africa.

In many of these households, fuel is burned indoors on open fires or poorly functioning stoves, often with no means of ventilation or smoke extraction. As a consequence, very large numbers of women and young children are exposed to high levels of air pollution, every day of the year. Indeed, it has recently been argued that the greatest global burden of air pollution exposure occurs not outdoors in the cities of the developed world, but indoors in poor rural communities (WHO 1997).

Women and children are particularly vulnerable to kitchen smoke (photo: Nigel Bruce)

There is now consistent evidence that indoor air pollution (IAP) increases the risk of childhood acute respiratory infections, the most important cause of death of children under five years in least developed countries; and there is also association with birthweight, infant and perinatal mortality, pulmonary tuberculosis, some forms of cancer and cataract. Although the risks are poorly quantified, indoor air pollution may be responsible for nearly two million excess deaths in Least Developed Countries (LDCs), and around 4% of the global burden of disease (Bruce, Perez-Padilla, Albalak, 2000).

Table (1.1) shows typical values for particulate levels in the kitchen of a rural home, compared to current standards advised by the US Environmental Protection Agency (EPA).

Table 1.1: Pollution level (PM_{10}) in micrograms per cubic metre of air($\mu g/m^3$)

Source of exposure	During use	24 hour average	Annual average
Biofuel (wood, dung, etc)	Typically from 1000 up to 20 000 or more	Typically 500 to 1000 or more	24 hour average levels are experienced every day
US- EPA standard		Only 1% of 24 hour periods to exceed 150	50

Health problems related to household energy

Each aspect of household energy use has particular health problems associated with it, which can usefully be considered under the following three headings:

Fuel Use

It is difficult to isolate any one cause of illness when extreme poverty, manifested in malnutrition, poor housing etc. affects much of peoples' lives. Nevertheless, there are several serious illnesses for which indoor air pollution from biomass is a major factor.

Smoke consists of many gases and particles which are known to have serious effects on health. The two major, well-identified constituents which are known to cause damage are: *particulates* and carbon monoxide.

Respirable particulates (PM_{resp}) are the small particles of smoke, less than 10microns in size, which are inhaled and penetrate deep into the lungs. There is mounting evidence that particulates are a major risk factor for two serious illnesses:

- Acute respiratory infections (ARI) in infants
- Chronic obstructive lung disease (COLD) in adults - especially for the women doing the cooking

Carbon monoxide (CO) is responsible for poisoning (mainly from charcoal, and coal use); and lung cancer (from coal use).

There is mounting evidence that cooking with biomass substantially increases the risk of developing active tuberculosis (Mishra, Retherford, Smith 1997) and there is an increased risk of low birth weight. Eye problems are also frequently reported, but there is very little research evidence to date.

- Other direct effects include burns (open fires, kerosene), poisoning (e.g. from children drinking kerosene stored in soft drink bottles).
- There are also wider environmental health effects relating to the fuel efficiency of the fire/stove, and also to greenhouse gas production, which is a function of the completeness of combustion - this arises because a number of *products of incomplete combustion* (PICs) are quite potent greenhouse gases.

Fuel production

Production of biofuels can affect health in a variety of ways, especially through local environmental consequences:

- Land use (which also has economic implications, with indirect health effects)
- Erosion, and effects on water supply, etc.
- Energy, and natural resource use, for example associated with charcoal production

Fuel collection and supply

- The time taken to collect wood, especially as this becomes scarce, has an opportunity cost, mainly for women (but also children where they are involved) in terms of education, economic activity, child care, etc.
- Danger to women in current and past war zones, e.g. from land mines
- Physical effects of carrying large quantities of fuel wood, etc., again mainly involving women.

Despite considerable evidence for a link between smoke pollution from biomass fuels and a number of health problems, comparatively little research has been carried out to evaluate efforts in the household energy field to reduce this exposure. Given the high levels of exposure to smoke, and the very large numbers of women and children exposed in the world's poorest communities, substantial reductions in indoor air pollution from biofuels can be expected to have a tangible and important impact on public health. This project is seeking to identify appropriate ways to effect substantial reductions in indoor air pollution.

Chapter 2 – The ITDG smoke and health project

Project overview

The main objectives of the project were twofold: to improve the quality of life, through reduction in indoor air pollution, for households in these study areas; and to develop a participatory methodology for further research into appropriate ways to alleviate indoor air pollution. These objectives were to be achieved through:

- Carrying out a baseline assessment of pollution and exposure, fuel use and house structure
- Identifying participatory ways of alleviating indoor air pollution through development and installation of interventions. (*Interventions*, within the context of this project, were identified as any changes which took place as a result of the project which could affect the levels of indoor air pollution to which the occupants of the kitchen, especially women and children, were exposed.)
- Evaluation of changes in pollution and exposure, and community views of the process used, and the acceptability and affordability of the interventions.
- Empowerment of communities by making them aware of the risks associated with household smoke and enabling mechanisms for its alleviation
- Development of a strategy in a national context for dissemination and sustainability within the market constraints of the communities
- Exchanging experience internationally to strengthen Kenyan work and to contribute to implementation of best practice in other countries
- Development of a replicable participatory methodology on appropriate methods for reducing indoor air pollution. This methodology will form the basis for future work in international comparative studies on indoor air pollution and interventions.

Project locations

All the field work took place in Kenya (see Box 2.1) and was carried out in communities in two rural areas with whom ITDG has been working for several years:

- A Maasai community in the Kajiado region, located some 80km south of Nairobi
- West Kenya, in the Kisii and Luhya communities in Nyamira district (60 km SSE of Kisumu) and Mumias, 40km west of Kakamega.

Box 2.1: Facts about Kenya

Kenya remains one of the poorer East African countries, with a per capita GNP of US$360million (ranking it 170th in the world) and an average annual growth rate of 0.1%. The rural population (comprising 68% of the total) is largely dependent on biomass fuels for energy. With 46.4% of the rural population living below the poverty line, 47% without access to improved water supplies, and infant mortality standing at 124 per 1000births (cf. 115 in 1980), the country displays both a high level of poverty and poor health, and a relatively slow pace of development. (World Development Report 2000/2001 - figures for 1998-99)

Although ITDG is well-recognised in these two regions, the households which were involved in the study had not benefited directly from earlier projects, so the homes were on the whole very traditional and suffered from high levels of indoor air pollution.

Table 2.1 summarises information on the incidence, intensity and severity of poverty for food, overall or hard-core poverty lines in the project areas. The incidence of poverty is measured by the numbers in the total population living below the poverty line. Because the communities with whom ITDG is working are among the poorest groups in these regions, the figures given in Table 2.1 are likely to be conservative. These figures are based on 1994 surveys.

Table 2.1: Incidence of poverty in the project areas						
Type of poverty	**Food poverty**		**Overall poverty**		**Hard-core poverty**	
Area	%	Actual numbers	%	Actual numbers	%	Actual numbers
Kajiado	30	80 369	22	60 926	14	39 257
Nyamira	55	227 046	52	261 698	34	171 757
Kakamega	49	514 297	51	537 141	32	327 307

Source: Ministry of Planning and National Development, Poverty in Kenya – first report, June 1998

Low incomes and wages characterize both Kajiado and West Kenya. However for the Maasai community (one of the poorer communities in Kajiado), food availability, especially a balanced diet, is lacking. The Maasai traditionally rely on livestock products as a source of food. On the other hand, poor nutritional status in the West Kenya region is attributed to low family incomes. The way this income is distributed across the family is such that women (who are the household managers) do not necessarily have access to it.

The Kajiado region

The area of Kajiado is 21,105 km^2 with a projected population in 1999 of 450 118 (growth rate of 5.54%) based on the 1989 census results (Kajiado District Development Plan, 1997-2001).

Economic Factors

- Employment levels were expected to be only half that of the total population in 1997. Employment is mainly in pastoral and livestock activities, and to a lesser extent in agricultural activities, waged employment, mining and quarrying.
- Child labour is common for males aged 12-15 years who have to look after livestock.
- Female-headed households cannot inherit property unless they have a boy child. This is a potential cultural barrier to development.

Health and infant mortality

- The most common diseases in the district are malaria and respiratory diseases. Others are eye infections, worms, diarrhoea, skin diseases, generally due to scarcity of water and poor sanitation.
- Infant mortality is estimated at 90 per 1000 live births. The figure was drawn in 1997, only from those who sought help from medical facilities. The figure may have been higher because a large proportion of the population has no access to the medical facilities. Causes are malaria, measles, gastro-enteritis, acute respiratory infections, malnutrition, and polio.

ITDG's links with the community

The ITDG Maasai Housing Programme is community-based, working mainly with women's groups and individual women in a pastoral area in Kenya. Traditionally semi-nomadic, the Maasai have, over the years, adopted a more sedentary lifestyle. Whilst maintaining cultural requirements of housing design, the project has made improvements in ventilation, natural lighting, maintenance and general comfort.

In 1993, the Maasai Housing Project in Kajiado made a preliminary study of the exposure to carbon monoxide and respirable particulates in two Maasai households, which showed that the cooks were exposed to unacceptably high levels of both these (Young, 94). ITDG has thus been working in the region for a very long time, and this facilitated the in-house testing procedures, as the staff were trusted and made welcome.

Maasai houses

In Kajiado, problems with smoke alleviation interventions reflect both the extreme poverty and cultural barriers within the community; lack of finance; famine; dilapidated houses; cultural barriers (men do not like being looked at while they eat).

The Maasai households have lived for years in unventilated houses due to their pastoralist lifestyle. Now that the life has become more sedentary, the demand for durable housing is increasingly a burden for women. The height of the houses being monitored in Kajiado was mainly between 4.5 feet and 7 feet, with one or two falling outside this range. There are no windows but very small pigeonholes and hence poor lighting and ventilation and are usually so dark that tin lamps have to be lit during the day. Accidents happen, such as burns, snake and spider bites, loss of items, stepping on sharp objects, houses are infested with vermin and rodents , such as fleas, rats and bedbugs. The houses, including the roofs, are predominantly built of mud, which is plastered onto woven wooden stakes. Some roofs are made of ferro-cement.

Typical Maasai house in Kajiado region (*photo: Nigel Bruce)*

Cooking practices

Food is usually cooked during the day so that the cook can walk outside during cooking periods to get away from the smoke in the house. Cooking is done on a three stone fire, and when people go to sleep, most of them do not put out the fire but cover it with ash so that the fire smoulders till morning when the fire is rekindled again.

West Kenya

In Western Kenya, the Smoke project worked in Nyamira and Mumias-Butere districts with the Kisii and Luhya communities. The two areas are different topographically since Kisii is a highland zone while Mumias is in the middle zone.

Mumias is a sugarcane growing area with very little land for subsistence farming and with relatively low rainfall patterns. Sugar cane is the major cash crop. It is grown commercially and sold to Mumias Sugar Company. Women have very little land for subsistence farming because the land is for sugar cane production and the income goes to the men. Some women opt to weed some two to three rows of sugar cane and in between the rows, they are allowed to grow beans**.**

Nyamira, on the other hand, is a highland region and subsequently has higher rainfall. There is a lot of subsistence farming (maize, beans, bananas, vegetables, tomatoes) in addition to the cultivation of tea, and coffee as cash crops.

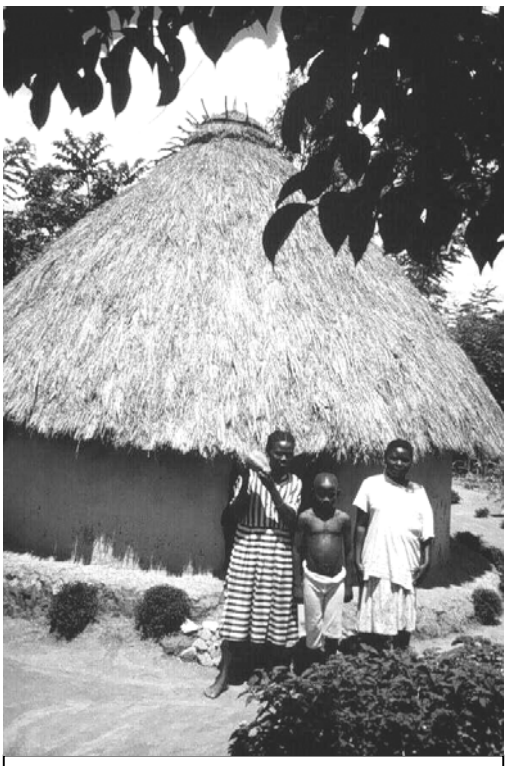
Nyamira, covers an area of 861 sq. km while Kakamega district covers an area of 2963 sq. km (Nyamira District Development Plan, 1994-1996; Kakamega District Development Plan, 1994 – 1996).

Health and infant mortality

- In West Kenya, the prevalent diseases are clinical malaria, upper respiratory tract infection, skin diseases, diarrhoea, intestinal worms and HIV/AIDS.

- By 1996, the infant mortality rate stood at 85 per 1000 live births. According to the KEPI (Kenya Extended Programme for Immunisation) survey carried out in 1992, the immunisation coverage for children under one year within the district was 72%.

ITDG has worked in West Kenya on household energy projects based on the production of the *Upesi* stove for over a decade. Initially focused on stove production, the project subsequently moved to providing a sustainable route through marketing and commercialization (Abbott, V. 2000). The smoke project is part of the current Stoves and Household Energy Programme, which also includes marketing and promotion training for stockists, retailers and promoters of stoves (Owala, 2001), ceramic stove production, and the production and distribution of training manuals on household energy. The work on smoke alleviation has benefited from the long-term relationship which ITDG has with communities in this area.



Kitchen in West Kenya: Note mud walls, thatch and absence of windows *(photo: ITDG)*

Housing

All the houses are built of mud; roofs are generally of thatch, although some are made of iron sheet. Houses in the two areas are characterised, as described below.

General household characteristics for Mumias

- Houses have racks on top of the fireplace, which may hinder erection of smoke hoods.
- The main fuel is firewood and crop residues.
- Kitchens are separate from the main houses.
- Kitchens have narrow eaves spaces of about 2 to 3 inches.
- Kitchens have small circular windows, hence the kitchen is poorly ventilated.
- Some houses used three- stone fires, mainly in homes where the Upesi project had not worked before. Many of the houses having improved cook stoves in the area owe the technology to the activities of the Upesi project.

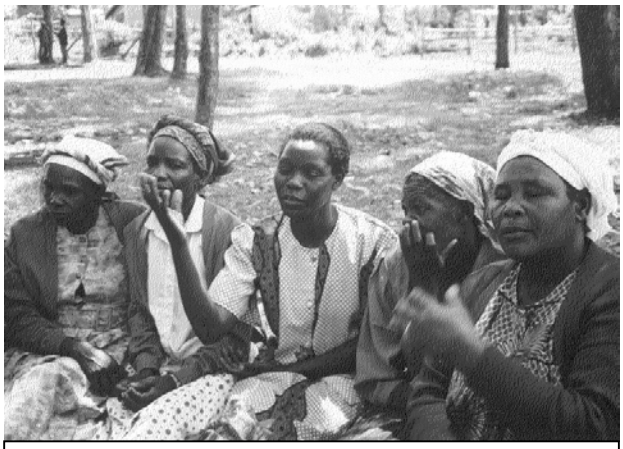
General household characteristics for Nyamira

- Kitchens separate from main house.
- No eaves spaces and, if present, they are blocked by the wood-rack (*Irongo*)
- Tiny windows and openings.
- In the period between the initial meeting with the women and the first pre-intervention monitoring, some people built upesi stoves in their kitchens

Chapter 3 – The participatory process

Community participation

Community participation has been a fundamental component of this project. This is built on ITDG experience over many years which shows that the people with whom the project works are best placed to express their own needs, and to identify potential solutions which suit their cultural, social and economic context. Indigenous knowledge has been highly valued throughout this work, and the community's (mostly women's) views and opinions have been listened to and addressed at all stages.



Women have gained in confidence through participatory activities *(photo: ITDG East Africa)*

During the Smoke project, participation has helped the communities to understand some of the problems they face as a result of smoke in their houses and also to be actively involved in formulating solutions. This chapter describes the participative methods used throughout the project. Participation has been on three levels:

- Community mobilisation and house selection
- Participatory Technology Development (PTD)
- Community participation in research

Community mobilisation

House selection incorporated the participative process, where women's groups were informed of the intentions of the project by the field staff, and helped in identifying houses based on the project's criteria. This ensured the community members' support throughout the project in terms of their time, being inconvenienced by the project equipment, adoption of new technologies, and other aspects of the project.

Participatory Technology Development (PTD)

PTD is the key development tool used throughout the project. It can be described as the collection of operational approaches, methods and techniques emphasising a high degree of user's participation in technology development; identification, implementation and development. It has its foundation on the premise that users are the best placed to decide which technologies they want to adopt, therefore greater participation may result in adoption of more appropriate technologies (ITDG Kenya Annual Report 1997).

All the smoke-alleviating technologies, developed in consultation with the cooks and their families, and all project stakeholders, therefore incorporate PTD elements. The technologies chosen must be acceptable, appropriate, durable, affordable and accessible to the local community.

Common themes and principles in PTD practice include an understanding of the following:

- That the community is the main actor in any development initiative
- That the outsider's role is basically supportive to the local efforts
- That the development activities should be oriented towards needs as perceived by the community
- That indigenous knowledge has an important role to play as a basis for action, support and strengthening
- That the key challenge is to tap the potential interaction between indigenous knowledge and that of outsiders.

Focus group meetings

Focus group meetings were held:

- To ensure that people's opinions and wishes were heard
- To sensitise the community to the risks of smoke, and enhance the households' awareness of the pre- and post-intervention benefits of the project interventions.

- To involve both men and women in participatory interactive communications on health related issues concerning their families.

The methodology included; brainstorming, discussions, examining case studies, interviews

Exchange visits

Exchange visits form an important part of local dissemination. They involve individual members of a community allowing others to visit their kitchens, in order to show off the interventions which have been installed. This happens naturally to a large extent within the community, but structured visits can also help to disseminate new ideas, as described in field reports (Box 3.1). Because it proved impossible to arrange visits between Kajiado and West Kenya, photographs were exchanged, to show each community what was happening in the other.

Box 3.1: Exchange visits

Exchange visits proved an effective way of disseminating information between community members. Initial reluctance on the part of many of the cooks turned to enthusiasm once they had seen the interventions in place in other people's kitchens.

- At the start of the project, only two of the women in Kajiado and none of the West Kenya women wanted smoke hoods installed. Once two had been installed in Kajiado, other women watched as the installation took place and observed how the smoke disappeared through the chimney. As a result, thirteen of the households opted for smoke hoods.

Constraints on community involvement

Although the women in the project areas were keen to be involved in every aspect of the project, various constraints limited their activities. The project staff had to avoid certain days e.g. market days (Wednesdays and Saturdays) and most meetings were held in the afternoon since the women were mostly committed in the morning hours to routine jobs such as fetching water, watering their animals. Distance was a major constraint for some of the women who had to trek several miles to get to the meeting venues. In West Kenya, some husbands were less supportive, unless their wives were 'paid' with flour, sugar etc. for the time spent.

Stakeholder involvement

Both local government ministries and locally-based organisations have been supportive and proactive throughout the project. This is essential in order to build the infrastructure necessary to make the successful interventions sustainable.

Women's groups

In mobilising and training the community, women's groups played a key role. During the project, women's groups usually co-ordinated activities and the meetings that were held with their members. The key informants were the group leaders (chair ladies) who served as a major link between the project facilitators and the community members.

Local government ministries

The project team enlisted the active support of the Ministry of Health, Ministry of Public Works and Housing, community development workers.

The African Medical and Research Foundation

The local Environmental Health Department of AMREF are involved in ongoing discussions with ITDG – East Africa on various collaborative ventures and support through their environmental health, sanitation and house improvement programmes to further this work.

The Maasai Technical Training Institute (MTTI)

The Maasai Technical Training Institute (MTTI) was engaged in the design, fabrication and procurement of the smoke hoods, and in artisanal training

The Jua Kali sector

The Jua Kali (informal manufacturing) sector has offered techniques that are affordable, sustainable and easy to adopt. Artisans have constructed all the hardware – hoods, frames for eaves spaces, windows.

Chapter 4 – Project activities

Project structure

The project was devised as a 'before-and-after' study, for which the key outputs would be substantial reductions in indoor air pollution and improvements in the quality of life for the beneficiaries. The opinions of the beneficiaries were recorded on the changes brought about by the interventions, whilst the air quality was monitored for reductions in particulates and carbon monoxide.

The project involved a multidisciplinary team, including fund raisers, project managers, scientific advisors, statisticians, field staff, enumerators, data entry/counter-check clerks, various partners (NGOs, government ministries, and research institutions), community artisans, and other community groups, as well as the individual householders themselves.

Although structured as a 'stand alone' project, the methodologies were closely aligned with those of earlier studies looking at the relationship between indoor air pollution and ill-health. The projected therefore benefited greatly from an adviser with direct experience in this related field.

Selection of households

The criteria for house selection were defined as follows:

- The most important criterion was willingness to participate in the project for its duration
- Preferably houses with children of 0 to 5 years. Mothers with children of this age tend to spend more time based in the kitchen and are therefore more vulnerable to smoke and the consequent respiratory problems
- A range of house types was chosen in West Kenya, from very traditional (often poor-quality) houses to houses which already had some improvements, such as *Upesi* stoves (see front cover) - this represented the living conditions experienced by the vast majority of people living in this region. The houses were identified and selected through the women's groups that ITDG had been working with since 1993 e.g. the Ichingo Women Group.
- In Kajiado, houses were selected that had not been improved by the Maasai Housing Project - again this represented the majority of homes. During house selection, the various women's groups were asked to identify houses that had not been improved under the Maasai Housing Project - the selection was done on ballot basis to avoid prejudices.

Training of enumerators

The field staff were trained as enumerators so that they could collect both numeric and descriptive data from each house. This involved training in: preparation of equipment, recording levels of smoke in each round, and recording household and house data.

Baseline survey

A baseline survey has two functions: to quantify the scale of the problem compared with international standards; to act as a baseline for any long-term changes brought about by interventions made during the project.

Data from the first two rounds of monitoring for particulates and carbon monoxide provided quantitative values for the levels of indoor air pollution in each of the households.

Questionnaires (see Annex 2) were used to identify key aspects of people's lives which might impact on indoor air pollution in their homes. These involved questions on households, housing, time budgets etc., a process which took about 20-45 minutes.

Focus-group discussions allowed the project team to discover the needs that the community identified as being most important to them. These discussions also allowed the team to find out the level of understanding within the community on the links between smoke and ill health.

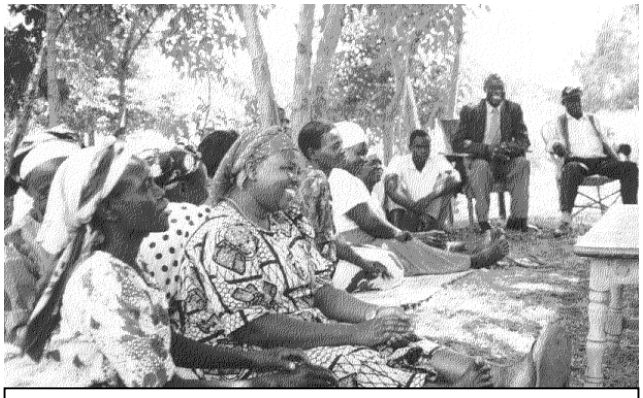
Visits to all the households allowed the team to discuss any traditional beliefs that needed to be considered when selecting interventions.

Discussions with all the households to decide on the interventions they needed.

Selection of interventions

A participatory approach was adopted right from the start, with individual and group discussions with the project families, especially the women, to identify possible smoke-alleviation methods which they would find acceptable, affordable and which were felt could be effective. This approach involved:

- Discussions on methods of smoke reduction, including improved stoves, windows, room height, smoke hoods etc.
- Exploring any locally available knowledge among community members on interventions
- Discussions on lighting and ventilation principles
- Involving women in selecting the locations of the interventions in the houses (windows, smoke hood/hoods)
- Discussing with the community members about the operation and maintenance of the interventions
- Discussing the efficiency of various interventions and the importance of opening windows and the realised benefits.
- Developing prototypes of the interventions e.g. windows, smoke hoods with the community
- Discussions on wood selection and method of drying and storage before the rains



Discussion groups were used to find out people's needs
(photo: ITDG East Africa)

The role of ITDG staff was to highlight the need for smoke interventions and to provide ideas and stimulate discussion on what might be done. The community members, in their turn, generated ideas based on their knowledge of the reality of their lives, identified constraints and ensured that the final decisions were realistic and in accordance with their wishes.

The information from these meetings was shared with the whole ITDG smoke team resulting in three possible types of intervention being identified: ventilation by enlarging the size of windows or opening eaves spaces; adding smoke hoods over the cooking area; and thirdly the option of installing improved cook stoves.

Although women in Kajiado believed (probably correctly) that those who had raised their roof height felt that indoor air pollution had been alleviated, the project team felt that this intervention was too costly to be reproduced by large numbers of people, so it was not adopted by the project.

The final design and materials used for the interventions was determined by the women themselves and availability of materials. In this way, local skills are used, the interventions are well accepted, and this should promote higher potential for future replication of the interventions in the area.

Quantitative measurement of indoor air pollution

Levels of indoor air pollution must be measured quantitatively, through smoke monitoring, and qualitatively, through interview and group discussion. This ensures that any interventions promoted in future work are effective as well as acceptable. For quantitative measurements, the levels of smoke must be measured both within the kitchen itself, and also the smoke inhaled by the person most affected - the woman of the house who does the cooking - described as 'the cook'.

Two key components of smoke were measured; respirable particulates (PM_{resp}) - less than 10microns diameter, and carbon monoxide (CO). The respirable particulates were measured using an air sampler, and carbon monoxide was measured using stain tubes.

Woman wearing CO monitor
(photo: Nigel Bruce)

Both respirable particulates and carbon monoxide were measured for each household over 24hours. However, since the monitoring was being conducted through the night as well as by day, it was important that the equipment used to measure the dose inhaled by the cook was as non-intrusive as possible. For this reason, the measured level of carbon monoxide she inhaled served as a proxy to assess the amount of particulates to which she had been exposed over this time. Statistical tests of association show a close correlation between CO and PM_{resp} in the kitchen, broadly in line with results reported by Naeher et al., hence it was felt appropriate to adopt this method for 24hour monitoring as the CO/ PM_{resp} relationship (Naeher LP, Smith KR, Leaderer BP, Neufeld L, Mage D, 2001). The stain tube used to record CO is silent, much smaller, and much less intrusive than a PM_{resp} monitor would be.

For each household, two rounds of monitoring were done before, and two rounds after, interventions had been installed in the houses. The two rounds were to reflect the wet and dry seasons and their effect on the levels of indoor air pollution in the kitchen.

Readings from the CO stain tubes were recorded by the field staff directly into the questionnaires. The particulates were collected on a filter paper which was dried and weighed using a six-point balance before and after monitoring to give the weight difference caused by the particulates. This procedure was organised by the project's scientific adviser at the University of Nairobi.

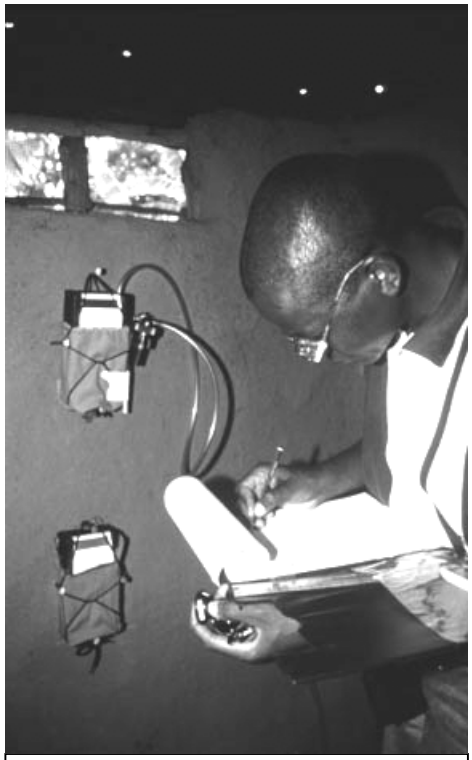
By comparing the levels of PM_{resp} and CO before and after particular interventions had been installed in a range of houses, it was possible to identify which interventions reduced indoor air pollution levels appreciably. A further step was to see the effect of the interventions on the indoor air pollution inhaled by the cook. The technical details involved in quantitative monitoring methods are detailed in Annex 1

Descriptive analysis and confounding variables

A series of questionnaires was devised (Annex 2), designed to be locally appropriate through discussions with members of the project team who were working in the field.

These questionnaires identified key aspects of people's lives which would be affected by their household energy use:

- A data collection sheet was used to record the levels of respirable particulates (PM_{resp}), levels of carbon monoxide in the room (CO) and personal carbon monoxide (PCO)for each household.
- A household questionnaire identified the size of the household, the way fuelwood was collected, the means



Member of field team recording PM level
(photo: Nigel Bruce)

of cooking, lighting, and other uses of energy.

- A house and kitchen questionnaire identified the type of house, the windows and other openings, the roof structure etc.
- Time/activity charts were used to determine when people were in the room whilst the fire was lit
- A basic health survey was done to identify the sort of problems which people were experiencing. Because of the low numbers in the study, this was not a baseline survey, but rather an overview of the health-related problems which the community identified.

Confounding variables are those aspects of people's lives (e.g. number of people to be cooked for), environmental factors (e.g. level of rainfall) which can influence the level of smoke pollution in the home and/or the level of personal exposure, and which are also associated with the interventions. The effects of these confounding factors needs to be considered if the actual impact of the interventions is to be correctly assessed. Changes in the most important confounding factors over the course of the project (in particular changes from the pre to post interventions periods) have therefore been reported, and the potential for confounding discussed. There is limited opportunity for formal statistical analysis of confounding due to the relatively small numbers in the study, but this will be carried out separately.

Focus group meetings

Pre-intervention meetings

Focus group meetings were held both before and after the interventions were installed. Pre-intervention discussions focused on which interventions were needed, the perceived causes of indoor air pollution, problems associated with indoor air pollution, and uses for smoke. The Smoke Project team gave a lead on some possible interventions that could be installed in the households such as enlarging the size of windows, eaves spaces, smoke hoods, installation of improved cook stoves. A sample of the outcome of these discussions is shown in Table 4.1.

Table 4.1 Pre-interventions discussions with women and men in West Kenya

Household number	Is smoke an issue?	Perceived causes	Problems	Smoke uses	Traditional beliefs	Possible changes?
HH 1	Yes	Lack of windows Door size Use of wet firewood Cooking for long hours Lack of other openings	Eye problems Cold	Chasing away insects Drying fuelwood Preserving cereals	None	Have windows Reposition the door Use bigger stoves
HH3	Yes	Position of the kitchen Size and position of window Lack of eave space Using wet fuelwood	Tearing of eyes and turning red Man avoids the kitchen Cold and flu	Was used for preserving cereals		
HH5	Yes	Size of openings Size of the kitchen	Colds and flu Coughs Tearing and red eyes	Insect repellent Drying fuel wood Preserving fuel	None	Build another kitchen Increase size of opening (window and eaves space)
HH6	Yes	Use of wet wood	Chest problem Breathing Cough	None	None	Build a new kitchen Is willing to work with the team on the changes required
HH8	Yes	Lack of eaves space Size of window Size of window	Tearing and red eyes Cough Flu	Dry fuelwood Preserving Cereals Insecticide	Smoke is a medicine for boils	Increase window size Increase eaves space Increase door size

Post-intervention West Kenya meetings
In the post-intervention period, they were used to understand the changes which had occurred in the communities over the duration of the project. Post-intervention discussions included training on how to use and maintain the interventions, suc as the need to open windows for them to be effective. The focus groups involved the stakeholder communities, mostly the participating women, and sometimes their husbands. They provided a forum for highlighting the effects and benefits of these activities.

Time-activity studies

Detailed time activity studies were undertaken for individual women and for groups in each area, in both wet and dry seasons. These studies reflect how changes in indoor air pollution level affect people's behaviour in their homes. The household questionnaires and the time activity studies combine to provide an overall picture of lifestyle among the Maasai and West Kenya communities. A typical day in the life of one of the Kajiado families is recorded as a time/activity record in Annex 3.

Installing interventions

There were four main types of interventions selected by the community members in Kajiado and West Kenya

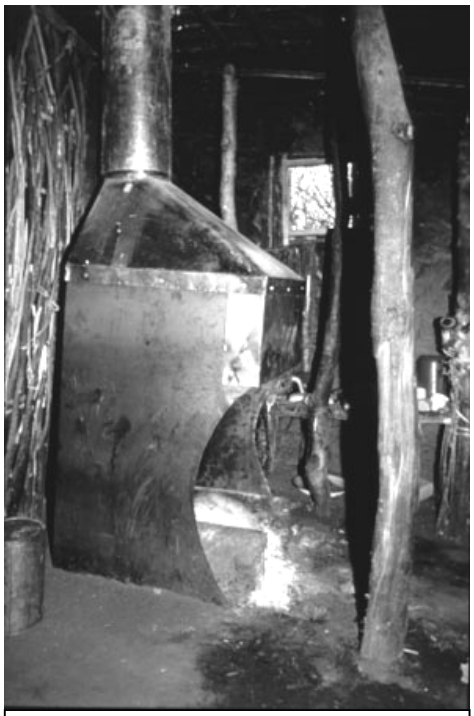
- Smoke hoods
- Eaves spaces
- Windows
- Improved stoves

Chapter 5 describes in detail the interventions that proved appropriate in each area.

Artisanal training

Kajiado

In Kajiado the Maasai Technical Training Institute in conjunction with the Ministry of Health undertook the training of artisans. The cooks were involved in material selection, sizing, shaping, positioning and production processes. The groups were able to show the desired positions of windows, vents, and the position of smoke hoods. They were shown pictures of different types of chimneys and smoke hoods from which to choose and were supplied with hard manila paper to design a model of the desired hood. The artisans transferred the design to the plates and sheets to cut out the parts and qualified artisans supervised production of the product. Pre-testing of the product with the households was crucial since changes were effected according to performance.



Smoke hood in Kajiado
(photo: Nigel Bruce)

West Kenya

An instructor from the Maasai Technical Training Institute trained two artisans and the Training Officer in the Kisumu YMCA. The training took eight days with all the five smoke hoods fabricated under his supervision. The hood designs were discussed in consultation with the households.

Follow-up activities

During this period, activities addressed sustainability at

local level:

- Operations and maintenance of the interventions
- Proper use of the interventions
- Personal and domestic hygiene
- Monitoring performance and effectiveness of interventions

The Ministry of Health, Culture and Social Services facilitated some of the meetings and exchange visits on domestic and personal hygiene, income generating project ideas, housing sanitation and operations and maintenance of the interventions.

Data analysis

Monitoring data was analysed to provide;

- A descriptive analysis of the baseline level of pollution in the study households, as well as the social, household, health and other factors which relate to the collection/supply and use of household energy in the home
- A description of the different types of intervention selected, their appearance (with photographs and sketches), the numbers of households adopting each intervention
- The change in ambient pollution levels in homes achieved through these interventions
- An assessment of the personal exposure for the woman (PCO) and time/activity assessments of women and young children

The results of the monitoring have been analysed statistically. Differences between the pre-intervention and post-intervention results reflect the impact of the project in terms of smoke alleviation. Annex 4 gives further details on the statistical methods adopted during the project.

Financial arrangements

The financial arrangements were different in each area. Kajiado suffers from severe poverty which was exacerbated, during the project period, by a drought which caused loss of livestock. Food aid was being sent by the government to the project families, and under these circumstances, it was agreed that there would be no costs incurred by the project families. Nevertheless, some provided assistance in installation of interventions, and some of the materials for building the interventions were purchased by the men in the community.

In West Kenya, there was a cost-sharing agreement from the start. Agreement was reached with the household owners of what each would contribute towards the cost of interventions.

Capacity building

Capacity building was addressed in several ways, and will form part of the ongoing smoke work:

Locally

- Involving other organisations throughout the project
- Training artisans
- Cost-sharing in West Kenya
- Dissemination through exchange visits, workshops, conferences, video

Internationally

- A new UK DfID-funded project 'Smoke, Health and Household Energy' started at the beginning of 2002. This project will build on the lessons learnt during this project to disseminate the methodologies in urban Kenya, Nepal and Sudan.
- Schemes to scale-up and commercialise the successful interventions within Kenya and the adjacent countries will form part of a further initiative through ITDG-East Africa and other key stakeholders.

Chapter 5 – Interventions

Table 5.1 outlines the selection made by each household. It can be seen that windows were popular in both areas, stoves and eaves spaces were favoured in West Kenya, whereas in Kajiado, smoke hoods were widely adopted.

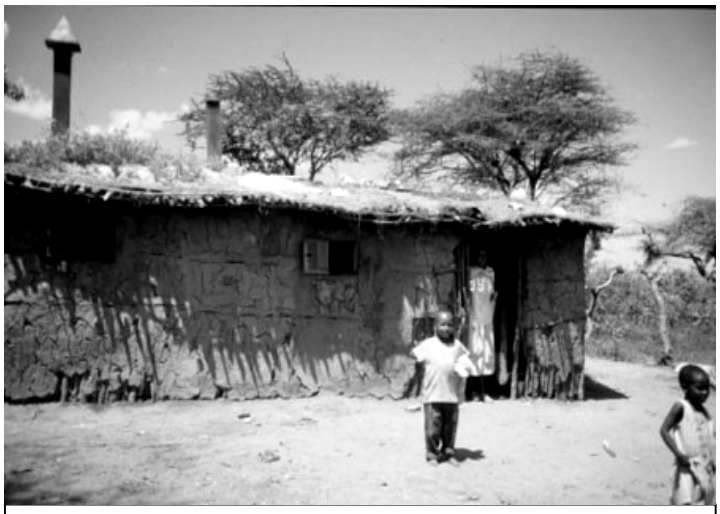
Table 5.1 Interventions installed in each household by end of project

	Window	Smoke hood	Upesi stove	Eaves spaces
West Kenya households	24	5	24	24
Kajiado households	24	12	0	2

**Some of these interventions were installed before project – see Chapter 6*

Smoke extraction through smoke hoods

A decision was made, in consultation with the community, to opt for smoke hoods rather than chimney stoves. This was based, in part, on two successful smoke hoods installed in Kajiado in the early 1990s and the failure of chimney stoves, several of which had been installed during a government scheme some years previously, and none of which had been used. In West Kenya there was little experience of either smoke hoods or chimneys. The figure opposite show the flue from the smoke hood and open window outside a house in Kajiado.

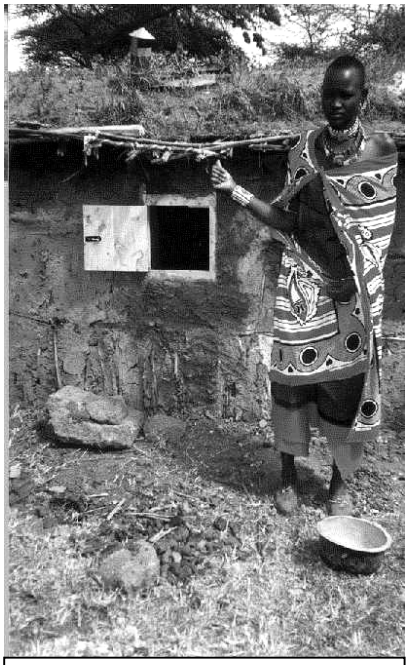


Maasai house showing open window and flue from smoke hood ***(photo: ITDG)***

Ventilation - through windows and eaves spaces

As shown in Chapter 2, the homes in Kajiado and West Kenya are entirely different constructions. However, in both areas, the rooms were largely unventilated, so windows and eaves spaces were adopted as possible interventions.

The windows were all of a standard size (0.3m x 0.3m), and cost approximately £10.40 to install, whilst the frame around the eaves space cost £4.35 (Exchange rate: 1UK£ ~ 115Ksh). The eaves spaces were cut into the wall at roof height and above the stove and a wooden frame inserted. They were made 150mm wide, and of varying length (long enough to vent the smoke as it reached roof height), typically 4-5m. Mesh was attached across the frame for added security, and to keep out rodents. Box 5.1 describes the participatory nature of the window installation.



Maasai woman showing newly installed window ***(photo: ITDG Kenya)***

Box 5.1:Case Study of Window installation

Process in HH40 (JK's house)
The installation exercise began in household 40 (JK's house) on 5th December. The team arrived in this boma at about 11.30 a.m. and asked the woman to suggest the window positions. JK. identified two locations which was a reflection of the husband's decision. The team however advised her that it would be better to have three windows instead of two to ensure through and cross ventilation. The size of the windows installed was 14 by 14 inches.

The exercise started at 12.00 noon and ended at 3.00 p.m. and it attracted women, men and children living in the same boma. The process created a lot of excitement as the house was opened up and some people sat inside to actually watch what was happening and they actively participated in passing their comments. After the first window was installed, JK (the owner of the house) really liked the idea of windows and decided she wanted four instead of three. However, the spectators were against the idea and said that this would infringe on her privacy since the house would be too open and the house would have less warmth which is characteristic of the Maasai houses. JK was actually lured to their idea and therefore the team only installed three windows in that house. JK later served the team with some tea (black tea since most of her cattle had died in the prolonged drought that the area had been experiencing).

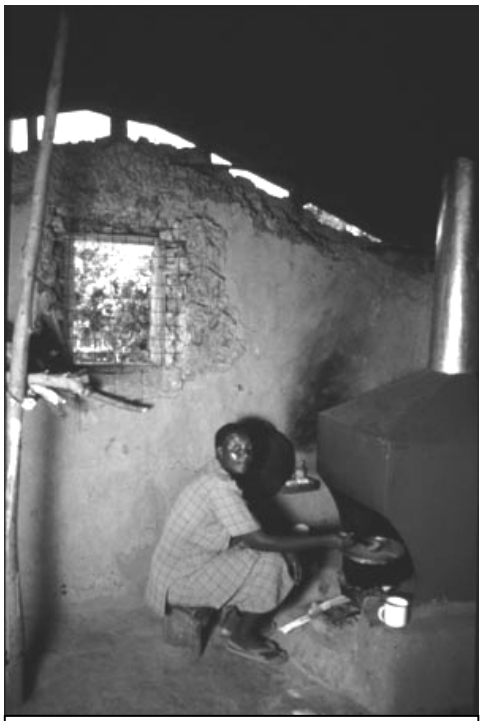
After witnessing the process in household 40, the husband of N. (household 41) was more than eager to have windows installed in his house the following day. In household 39, four windows were installed on 7th December.

Improved combustion through improved stoves

West Kenya has a good tradition of improved stove use where it is well-suited to the typical kitchens in the region. The Upesi stove, promoted through the household energy programmes, has been shown to reduce fuel use by about 40% *(Habermehl, 1994; Abbott, 2000) compared with three-stone fires. A key element in its success has been the training of the producers, sellers and promoters of the stoves (most of whom are local women), in effective dissemination techniques (Owala, 2001). This often involves demonstrations, and advice on the installation of the stoves. Many of the households with these improved stoves have reported marked improvements in the household environment, saying that:

- the kitchens are cleaner;
- the children's safety from domestic fires/accidents have been improved; and
- there is considerable saving in the use of fuel wood.

Upesi stoves cost approximately £1.20 for a single stove, and £2.40 for a double– to buy, and a £0.40-0.80 – to install.



West Kenya kitchen, showing upesi stove, smoke hood, eaves space and window ***(photo: ITDG East Africa)***

Interventions in Kajiado

The most popular intervention were windows, which everyone adopted, with about half the households opting for smoke hoods. None of the households adopted improved stoves and only two households requested eaves spaces. The eaves spaces were considered draughty, and also the house structure made it very difficult to cut eaves spaces at the top of the wall.

Interventions in West Kenya

As part of the participatory process with the household owners in the study, the West Kenya team selected a menu of activities to identify appropriate interventions:

- Visiting all the households to discuss the communities' perception of the indoor air pollution problems and the perceived causes of indoor air pollution. For most households, this discussion was held in the presence of the spouses.
- Exhibiting photographs of the interventions that had been completed in Kajiado evoked an enthusiastic response as described in field reports (Box 5.2)
- Revisiting the households to finalise decisions on the types of intervention and the method of installation.
- Reaching agreement with the household owners of what ITDG's contribution towards the interventions would be, and what would be met by the household.

Box 5.2: Technology transfer through photographs
Pictures of the Kajiado smoke hoods were shown to the households who were very excited to have the same in their houses. On brick smoke hoods, the Mumias community said it looked odd on the thatched roof and hence dropped the idea. Five smoke hoods were fixed in both Nyamira and Mumias with all the women very happy and excited. At one homestead, people danced with a lot of vigour to a traditional dance commonly known as "Mwana Abili Kayai" causing a stampede with a lot of ululation and thunder on the new technology.

The kitchen owners worked towards the improvements, identifying and negotiating with the artisans, and installing Upesi stoves in those houses where they had not previously been used.

Maintenance and use of interventions

- Discussions were held with households on the maintenance and use of each of these interventions – e.g. it was found that smoke hoods work better when there is a window directly opposite the fire, which improves combustion and when they are kept free from soot.
- It was found that during wet weather, families were closing all the windows – when cooking, the households are advised to keep some of the windows open to facilitate combustion and to minimise the pollutant concentration in the kitchen
- In West Kenya, the hood is made more durable by encasing the bottom of the hood in mud, and painting the hood to minimise rusting.

Chapter 6: Key findings affecting the communities in Kajiado and West Kenya

Descriptive analysis of households in Kajiado and West Kenya

Households

Table 6.1 looks at the number of occupants in each of the households in each area, before and after the interventions were installed. The large differences in children's ages reflect the fact that over a year had passed between pre- and post-intervention monitoring, age was not something which was considered important in the communities, and furthermore, the children often move between houses, especially in the Kajiado community. Adjusted meals reflect the smaller portions required by women and children, compared to those eaten by men (Stewart et al., 1987). It can be noted that there was no major change in the overall numbers of meals being cooked before and after the interventions were installed. Because of the famine in Kajiado, dried maize was included in the diet, which needed more cooking in the post-intervention period. Nevertheless, the questionnaires did not reflect any substantial change in the hard food / soft food ratio. (Hard foods included maize, beans etc. soft foods included tea, vegetables, milk, porridge)

The time spent cooking in Kajiado is considerably greater in the pre-intervention rounds. This reflects comments made by the women to the team that it is much easier to cook in kitchens where they can see what is happening clearly.

Table 6.1: Households – descriptive analysis

Characteristic		**Kajiado**				**West Kenya**			
		Pre-intervention		**Post - intervention**		**Pre-intervention**		**Post - intervention**	
	Level	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Age of woman - years	<19	1	5	0	0	0	0	0	0
	20-29	8	42	13	54	5	20	3	13
	30-39	7	37	5	21	7	28	6	25
	40-49	1	5	4	17	9	36	8	33
	50-59	2	11	2	8	4	16	5	21
	60+	0	0	0	0	0	0	2	8
1st child's age (median)		8		5		7.9		4.38	
2nd child's age (median)		4.5		5		4.3		3.5	
3rd child's age (median)		2.5		2		3.5		2.75	
Time spent in kitchen		2.5		1.52		3.8		3.14	
Pre/post reduction (%)		39.2				17.3			
Type of food – % per meal	Soft	79		74		97		93	
	Hard	21		26		0		06	
	Both	0		0		0.03		0.01	
Adjusted servings/household/meal*		3.88		4.18		4.68		4.94	

** Child meals = 0.5 x adult meals: Female = 0.8 x male meals (equal nos. of male/female assumed)*

Houses and kitchens

The data in Table 6.2 shows that wood is overwhelmingly the major fuel, with some use of biomass residues, especially in West Kenya. Kerosene is mainly used for lighting (using wick lamps) although a few households use it for secondary fuel for cooking. It would appear that fuel is not routinely dried. Whilst fuel is scarce, there was no significant change in its availability before and after the installation of interventions – scarcity was reported at around 20-25% in Kajiado, and 60-70% in West Kenya.

Table 6.2: Houses and kitchens – descriptive analysis

		Kajiado				West Kenya			
		Pre-intervention (n=19)		*Post-intervention (n=24)*		*Pre-intervention (n=25)*		*Post-intervention (n=24)*	
Characteristic	**Level**	***n***	***(%)***	***n***	***(%)***	***n***	***(%)***	***n***	***(%)***
Main Fuel	Wood	19	100	23	96	25	100	24	100
	Residues & dung	0	0	1	4	0	0	0	0
Secondary fuel	Wood	0	0	0	0	0	0	0	0
	Residues & dung	2	10	3	12.5	13	52	9	38
	Charcoal	0	0	3	12.5	1	4	1	4
	Kerosene	0	0	0	0	1	4	2	8
Drying fuel	Usually	0	0	1	4	19	76	17	71
	Sometimes	4	21	4	17	6	24	6	25
	Never	15	79	19	79	0	0	1	4
Adequacy of fuel	Very adequate	11	58	10	42	4	16	3	12
	Just adequate	4	21	8	33	2	8	6	25
	Rather scarce	2	10.5	6	25	10	40	10	42
	Very scarce	2	10.5	0	0	9	36	5	21

Interventions

The results in Table 6.3 reflected the interventions that had been installed in the kitchens of the communities in Kajiado and West Kenya during the study–the vast majority of these changes were as a result of the project.

Table 6.3: Houses and kitchens – Interventions installed

		Kajiado				West Kenya			
		Pre-intervention (n=19)		*Post-intervention (n=24)*		*Pre-intervention (n=25)*		*Post-intervention (n=24)*	
Characteristic	**Level**	***n***	***(%)***	***n***	***(%)***	***n***	***(%)***	***n***	***(%)***
Smoke extraction	None	19	100	11	46	25	100	19	80
	Hoods/chimneys	0	0	12	50	0	0	5	20
	Missing data	0	0	1	4	0	0	0	0
Eaves	None	19	100	22	92	9	36	0	0
	Medium	0	0	2	8	13	52	9	38
	Large	0	0	0	0	3	12	15	62
Stove	Improved	0	0	0	0	10	40	21	88
	Traditional	19	100	24	100	15	60	1	4
	Other or missing					0	0	2	8
Primary window	No window	0	0	0	0	7	28	0	0
	25mm-149mm	16	84	0	0	1	4	1	4
	150mm-600m	3	16	24	100	12	48	14	58
	>0.6m	0	0	0	0	7	28	9	38
Second window*	25mm-149mm	16	84	0	0	0	0	1	4
	150mm-0.6m	3	16	24	100	9	36	12	50
	>0.6m	0	0	0	0	1	4	11	46
	No window	0	0	0	0	15	60	0	0

**The increase in size is for the two largest windows. In Kajiado, several of the houses had three or four installed in total*.

Women's health

This project was designed to look at the smoke-alleviating effects of installing interventions; it did not attempt to measure the health effects directly. Nevertheless, the pollution indicators recorded reflect the likely health impact of kitchen smoke on the cook and her children. Table 6.4 is a summary of the health problems reported by the cooks in the questionnaires, and is intended to give an overview of the smoke-related health problems experienced in each community. It is based on standard questions from the Medical Research Council for respiratory disease. Because of the limited numbers involved, it was statistically inappropriate to look at the before/after effects of interventions on health. Table 6.4 therefore gives a compiled number of reported ailments for each community, combining all pre- and post-intervention data.

Table 6.4 Health problems identified by the cooks

		Kajiado		**Kisumu**	
		No. of records	**% with problem**	No. of records	**% with problem**
Cough	i)First thing in the morning	74	**24.32**	97	**16.49**
	ii)During day (or at night in wettest coldest season)	65	**27.69**	76	**21.05**
	If 'yes' to i) or ii), cough most days for up to 3 months a year	23	**26.09**	26	**26.92**
Phlegm	i)From chest in the morning during cold/wet season	73	**20.55**	102	**20.59**
	ii)During day (or at night in wettest coldest season)	70	**21.43**	87	**21.84**
	If 'yes' to i) or ii), phlegm most days for up to 3 months a year	17	**5.88**	44	**13.64**
Cough & phlegm	In last three years, cough and phlegm together lasting 3 weeks or more	73	**13.70**	98	**18.37**
Wheezing	Wheezing or whistling in chest in last 12 months	74	**13.51**	79	**24.05**
	Woken up last 12mths at night with shortness of breath	73	**10.96**	90	**27.78**
Chest illness	During past 3 years preventing usual activities for as much as a week	74	**17.57**	78	**28.21**
TB	Ever been told by a doctor that suffering from tuberculosis	74	**0.00**	98	**4.08**
Eyes	Red, watering eyes sometimes or much of time	47	**55.32**	67	**17.91**
	Sore, sometimes or much of time	47	**27.66**	66	**13.64**
	Swollen, sometimes or much of time	47	**12.77**	66	**10.61**
	Affected by light, sometimes or much of time	47	**61.70**	64	**20.31**
	Vision impaired, sometimes or much of time	47	**29.79**	67	**38.81**

Quantitative results on changes in indoor air pollution

Overall pollution levels

The pre-intervention levels of PM_{resp} in Kajiado were over 5000$\mu g/m^3$ and in West Kenya were over1700$\mu g/m^3$. Kitchen CO levels were 74ppm in Kajiado and over 10ppm in West Kenya and personal CO (COwm) was about 7ppm and 4ppm in Kajiado and West Kenya respectively. It should be noted that the personal measures do not give any indicator of the peak levels either in the room or experienced by the woman.

Overall changes in 24-hour averages following the interventions in Kajiado showed a 36 % reduction in PM_{resp}, and in West Kenya there was an overall reduction of over 60%. Significant substantial reductions were observed in both Kajiado and West Kenya for particulates and room CO. There were reductions in personal PCO but these reached only a marginal level of signficance (p=0.06Wilcoxon).

For West Kenya, mean levels are consistently lower (30-45% reduction) for monitoring at 2.5ft compared to 4ft. The results in both pre- and post-intervention rounds show this characteristic. This emphasises the need for consistency in measurement, and the problems of comparing results with data from other projects.

Table 6.5: Changes in 24hour respirable particulates – all interventions

		Kajiado (all 4ft)			West Kenya (see height)		
	Height (ft)	*N*	*Mean*	*(SE)*	*N*	*Mean*	*(SE)*
Pre-intervention mean	4	23	5526.7	534.2	23	1713.6	260.9
Post-intervention mean		23	3522.4	510.6	23	628.9	70.2
Difference (pre/post)		23	2004.3	850.6	23	1084.7	261.1
p-value: Wilcoxon			0.048			0.000	
p-value: T-test			0.028			0.000	
Pre-intervention mean	2.5				23	993.0	176.6
Post-intervention mean					23	421.9	51.6
Difference (pre/post) (95% CI)					23	571.1	186.4
p-value: Wilcoxon						0.003	
p-value: T-test						0.006	

	Kajiado and West Kenya combined – 4ft		
	N	*Mean*	*(SE)*
Pre-intervention mean	46	3620.15	408.78
Post-intervention mean	46	2075.63	333.84
Difference (pre/post) (95% CI)	46	1544.52	445.24
p-value: Wilcoxon		<0.001	
p-value: T-test		0.001	

Table 6.6: Changes in 24hr room carbon monoxide – all interventions							
		Kajiado (all 4ft)			West Kenya (see height)		
	Height (ft)	*N*	*Mean*	*(SE)*	*N*	*Mean*	*(SE)*
Pre-intervention mean	4	23	74.66	5.89	23	10.08	2.12
Post-intervention mean		23	51.37	8.10	23	4.69	0.45
Difference (pre/post) (95% CI)		23	23.28	8.92	23	5.39	2.21
p-value: Wilcoxon			0.010			0.018	
p-value: T-test			0.016			0.023	
Pre-intervention mean	2.5				23	6.67	1.26
Post-intervention mean					23	3.64	0.37
Difference (pre/post) (95% CI)					23	3.03	0.41
p-value: Wilcoxon						0.043	
p-value: T-test						0.085	

	Kajiado and West Kenya combined – 4ft		
	N	*Mean*	*(SD)*
Pre-intervention mean	46	42.37	5.72
Post-intervention mean	46	28.03	5.31
Difference (pre/post) (95% CI)	46	14.34	4.74
p-value: Wilcoxon		0.004	
p-value: T-test		0.001	

Table 6.7: Changes in 24 hour personal carbon monoxide – all interventions						
Time	**Kajiado**			**West Kenya**		
	N	***Mean***	***(SE)***	***N***	***Mean***	***(SE)***
Pre-intervention mean	23	6.98	0.75	24	4.16	0.97
Post-intervention mean	23	6.54	1.14	24	2.83	0.46
Difference (pre/post) (95% CI)	23	0.44	1.14	24	1.34	0.97
p-value: Wilcoxon		0.229			0.194	
p-value: T-test		0.704			0.183	

PCO	Kajiado and W. Kenya combined		
	N	*Mean*	*(SE)*
Pre-intervention mean	47	5.54	0.64
Post-intervention mean	47	4.65	0.66
Difference (pre/post) (95% CI)	47	0.90	0.74
p-value: Wilcoxon		0.060	
p-value: T-test		0.233	

Changes in pollution associated with specific interventions

Effect of hoods
Prior to the study, no smoke extraction hoods or chimneys had been installed in any of the study kitchens. During the project, twelve were installed in Kajiado, and five were installed in West Kenya.

A comparison of homes that received hoods with those that did not, showed substantial ly greater reductions in respirable particulates in both Kajiado and West Kenya respirable particulates as a result of this intervention; marked reductions were also seen for kitchen CO and PCO.

Table 6.8: Changes in 24hr respirable particulates: Effect of hoods					
Kajiado					
Time		**Hoods (n=10)**		**Other interventions (n=13)**	
		mean	***(SE)***	***mean***	***(SD)***
Pre-intervention		5991.2	1122.1	5169.4	4178.0
Post intervention		1439.1	322.4	5124.9	541.7
Difference (pre/post)		4552.1	1321.1	45.5	777.2
p-value:Wilcoxon		0.007		0.81	
p-value: T-test		0.007		0.96	
Difference in pre- intervention values		509.5	1031.2		
p-value:Mann Whitney		0.6300			
p-value: T-test		0.90			
Difference in post intervention values		3764.5	652.5		
p-value: Mann Whitney		<0.001			
p-value: T-test		<0.001			
West Kenya (note only 5 with hoods)					
Time	Height (ft)	**Hoods (n=5)**		**Other interventions (n=18)**	
		mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	4ft	1167.6	434.9	1865.2	305.8
Post-intervention		345.9	87.7	707.5	77.3
Difference (pre/post)		821.7	449.9	1157.8	313.1
p-value: Wilcoxon		0.14		0.002	
p-value: T-test		0.14		0.001	
Difference in pre- intervention values		647.8	617.9		
p-value:Mann Whitney		0.21			
p-value: T-test		0.49			
Difference in post intervention values		458.5	244.4		
p-value: Mann Whitney		0.01			
p-value: T-test		0.25			
Pre-intervention	2.5ft	1158.1	392.1	947.2	202.4
Post intervention		208.5	30.7	481.2	58.2
Difference (pre/post)		950.0	396.4	466.0	210.2
p-value: Wilcoxon		0.08		0.74	
p-value: T-test		0.08		0.04	
Difference in pre- intervention values		192.9	419.1		
p-value:Mann Whitney		0.79			
p-value: T-test		0.65			
Difference in post intervention values		320.34	145.05		
p-value: Mann Whitney		0.002			
p-value: T-test		0.04			

Table 6.8: Changes in 24hr respirable particulates: Effect of hoods (contd) Kajiado and West Kenya combined				
Time	**Hoods (n=15)**		**Other interventions (n=31)**	
	mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	4383.3	962.8	3250.9	385.6
Post intervention	1074.7	253.5	2560.0	457.8
Difference (pre/post)	3308.6	994.0	690.9	379.0
p-value:Wilcoxon	0.001		0.03	
p-value: T-test	0.005		0.08	
Difference in pre- intervention values	836.6	876.7		
p-value:Mann Whitney	0.69			
p-value: T-test	0.35			
Difference in post intervention values	1516.3	503.7		
p-value: Mann Whitney	0.020			
p-value: T-test	0.004			

Table 6.9: Changes in 24hour kitchen carbon monoxide: effect of hoods					
Kajiado					
Time		**Hoods (n=10)**		**Other interventions (n=13)**	
		Mean	***(SE)***	***mean***	***(SE)***
Pre-intervention		67.81	10.16	79.92	6.90
Post intervention		15.05	5.00	79.31	6.99
Difference (pre/post)		52.76	11.57	0.61	9.09
p-value: Wilcoxon		0.005		0.83	
p-value: T-test		0.001		0.95	
Difference in pre- intervention values		8.42	12.85		
p-value:Mann Whitney		0.24			
p-value: T-test		0.52			
Difference in post intervention values		65.21	8.72		
p-value: Mann Whitney		<0.001			
p-value: T-test		<0.001			
West Kenya – note only 5 with hoods					
Time	Height (ft)	**Hoods (n=5)**		**Other interventions (n=18)**	
		Mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	4ft	7.79	3.17	10.72	2.58
Post-intervention		2.00	0.69	5.44	0.39
Difference (pre/post)		5.79	3.28	5.28	2.72
p-value: Wilcoxon		0.08		0.10	
p-value: T-test		0.15		0.07	
Difference in pre- intervention values		2.93	5.07		
p-value:Mann Whitney		0.41			
p-value: T-test		0.57			
Difference in post intervention values		3.79	1.05		
p-value: Mann Whitney		0.002			
p-value: T-test		0.002			
Pre-intervention	2.5ft	7.69	5.43	6.39	6.3
Post intervention		1.75	0.92	4.17	1.58
Difference (pre/post)		5.94	5.73	2.22	6.94
p-value: Wilcoxon		0.04		0.57	
p-value: T-test		0.08		0.19	
Difference in pre- intervention values		0.90	3.00		
p-value:Mann Whitney		0.41			
p-value: T-test		0.77			
Difference in post intervention values		2.48	0.73		
p-value: Mann Whitney		0.004			
p-value: T-test		0.003			
Kajiado and West Kenya combined					
Time		**Hoods (n=15)**		**Other interventions (n=31)**	
		mean	***(SE)***	***mean***	***(SE)***
Pre-intervention		47.81	10.12	39.79	7.00
Post intervention		10.70	3.67	40.36	7.25
Difference (pre/post)		37.10	9.66	22.55	4.05
p-value: Wilcoxon		0.001		0.26	
p-value: T-test		0.002		0.42	
Difference in pre- intervention values		6.15	12.16		
p-value:Mann Whitney		0.73			
p-value: T-test		0.61			
Difference in post intervention values		25.33	7.86		
p-value: Mann Whitney		0.007			
p-value: T-test		0.002			

Table 6.10: Changes in 24hour personal carbon monoxide: Effect of hoods				
Kajiado				
Time	**Hoods (n=10)**		**Other interventions (n=13)**	
	mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	6.92	0.73	7.04	1.22
Post intervention	4.93	1.73	7.79	1.47
Difference (pre/post)	1.99	1.39	-0.75	1.69
p-value: Wilcoxon	0.07			
p-value: T-test	0.19			
Difference in pre- intervention values	0.520	1.40		
p-value:Mann Whitney	0.22			
p-value: T-test	0.72			
Difference in post intervention values	3.10	2.16		
p-value: Mann Whitney	0.009			
p-value: T-test	0.17			
West Kenya – note only 5 with hoods				
Time	**Hoods (n=5)**		**Other interventions (n=18)**	
	mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	3.30	0.92	4.43	1.27
Post-intervention	1.33	0.27	3.11	0.56
Difference (pre/post)	1.97	0.96	1.32	1.28
p-value: Wilcoxon	0.043		0.65	
p-value: T-test	0.100		0.32	
Difference in pre- intervention values	1.46	2.47		
p-value:Mann Whitney	0.62			
p-value: T-test	0.56			
Difference in post intervention values	1.88	1.08		
p-value: Mann Whitney	0.003			
p-value: T-test	0.10			
Kajiado and West Kenya combined				
Time	**Hoods (n=15)**		**Other interventions (n=31)**	
	Mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	5.71	0.72	5.52	0.92
Post intervention	3.73	1.22	5.07	0.80
Difference (pre/post)	1.98	0.95	0.45	1.02
p-value: Wilcoxon	0.01		0.91	
p-value: T-test	0.06		0.66	
Difference in pre- intervention values	0.20	1.32		
p-value:Mann Whitney	0.28			
p-value: T-test	0.88			
Difference in post intervention values	1.44	1.36		
p-value: Mann Whitney	0.018			
p-value: T-test	0.30			

Effect of eaves spaces

In Kajiado, eaves spaces were adopted by only two households, whereas in West Kenya, where the structure of the houses is more conducive to the enlargement of the eaves, every house decided to adopt this intervention to some extent. Eaves spaces provided substantial benefits in West Kenya, reducing respirable particulates by about 60% where the eaves spaces increased from 'small' to large', and to a lesser extent where moderate eaves spaces were enlarged. An interesting aspect of this intervention is that it was very successful in eliminating all the very high levels of particulates. This can be observed in the marked reduction in standard error, which is a measure of the scatter of the data. This is most evident at the 4ft level, where the smoke is nearer the eaves spaces and further away from the fire.

Table 6.11 Change in 24hour respirable particulates – effect of eaves spaces				
	Eaves spaces – 4ft		Eaves spaces – 2.5ft	
	mean	*(SE)*	*mean*	*(SE)*
Small to large eaves (n=8)				
Pre-intervention	2042.80	331.41	821.35	111.90
Post-intervention	766.70	105.70	464.65	96.66
Difference (pre/post)	1276.10	287.61	356.69	78.65
p-value: Wilcoxon	0.012		0.012	
p-value: T-test	0.003		0.003	
Moderate to large eaves (n=3)				
Pre-intervention	962.97	373.83	514.19	220.19
Post-intervention	469.87	115.55	407.50	128.67
Difference (pre/post)	493.11	258.42	106.69	330.18
p-value: Wilcoxon	0.11		0.59	
p-value: T-test	0.20		0.78	

Table 6.12: 24 hour kitchen carbon monoxide – effect of eaves spaces				
	Eaves spaces – 4ft		Eaves spaces – 2.5ft	
	Mean	*(SE)*	*mean*	*(SE)*
Small to large eaves n=8				
Pre-intervention	8.54	1.33	5.18	0.80
Post-intervention	5.65	0.50	4.32	0.52
Difference (pre/post)	2.89	1.44	0.86	1.00
p-value: Wilcoxon	0.092		0.482	
p-value: T-test	0.084		0.42	
Moderate to large eaves (n=3)				
Pre-intervention	4.93	1.59	3.19	0.14
Post-intervention	4.86	0.42	4.03	0.69
Difference (pre/post)	0.07	2.00	0.83	0.64
p-value: Wilcoxon	1.00		0.18	
p-value: T-test	0.975		0.321	

Table 6.13: 24 hour personal carbon monoxide – effect of eaves spaces		
	Mean	*(SE)*
Small to large eaves n=8		
Pre-intervention	4.08	1.07
Post-intervention	3.62	1.21
Difference (pre/post)	0.46	0.43
p-value: Wilcoxon	0.26	
p-value: T-test	0.32	
Moderate to large eaves (n=3)		
Pre-intervention	9.57	7.30
Post-intervention	2.36	0.27
Difference (pre/post)	7.21	7.54
p-value: Wilcoxon	1.00	
p-value: T-test	0.44	

Effect of stoves

In Kajiado, it was evident to the team that the cooks in this region wished to continue using the traditional three-stone fire, and there was no desire for change to a fuel-efficient stove. In West Kenya, although data from the houses receiving stoves during the project indicates a reduction in all variables, a similar difference is observed for those houses which have had stoves from the start of the project. This suggests that the effect is due to the eaves rather than the stoves, since all of these houses had some enlargement of eaves spaces. Further analysis of these inter-related effects is not being carried out due to the relatively small numbers. Only West Kenya houses without hoods were included in this analysis.

Table 6.14: 24 hour respirable particulates – effect of stoves

Height = 4ft				
Time	**Stoves installed during project N=8**		**Stoves throughout N=10**	
	Mean	***(SD)***	***mean***	***(SD)***
Pre-intervention	1929	1347	1814	1327
Post-intervention	874	345	574	258
Difference (pre/post) and 95% CI	1055	1543	1239	1209
p-value: Wilcoxon	0.07		0.005	
p-value: T-test	0.09		0.01	
Difference in post intervention values				
p-value:Wilcoxon				
p-value: T-test				
Height = 2.5ft				
Time	**Stoves installed during project N=7**		**Stoves throughout N=10**	
	Mean	***(SD)***	***mean***	***(SD)***
Pre-intervention	971	759	979	990
Post-intervention	446	247	485	262
Difference (pre/post) and 95% CI	524	920	494	938.81
p-value: Wilcoxon	0.87		0.51	
p-value: T-test	0.18		0.13	
Difference in post intervention values				
p-value:Wilcoxon				
p-value: T-test				

Table 6.15: 24 hour kitchen carbon monoxide – effect of stoves				
Height = 4ft				
Time	**Stoves installed during project N=8**		**Stoves throughout N=10**	
	Mean	***(SD)***	***mean***	***(SD)***
Pre-intervention	10.63	10.22	10.79	12.05
Post-intervention	6.09	2.02	4.92	1.09
Difference (pre/post) and 95% CI	4.53	11.99	5.88	11.75
p-value: Wilcoxon	0.73		0.07	
p-value: T-test	0.67		0.15	
Difference in post intervention values				
p-value:Wilcoxon				
p-value: T-test				
Height = 2.5ft				
Time	**Stoves installed during project N=7**		**Stoves throughout N=10**	
	Mean	***(SD)***	***mean***	***(SD)***
Pre-intervention	6.67	5.82	6.62	7.08
Post-intervention	3.93	1.8	4.13	1.42
Difference (pre/post) and 95% CI	2.74	7.21	2.5	7.17
p-value: Wilcoxon	1.0		0.05	
p-value: T-test	0.55		0.13	
Difference in post intervention values				
p-value:Wilcoxon				
p-value: T-test				

Table 6.16: 24 hour personal carbon monoxide – effect of stoves				
Time	**Stoves installed during project N=8**		**Stoves throughout N=10**	
	Mean	***(SD)***	***mean***	***(SD)***
Pre-intervention	2.89	0.97	5.67	7.09
Post-intervention	2.72	1.24	3.42	3.06
Difference (pre/post) and 95% CI	0.17	1.65	2.25	7.14
p-value: Wilcoxon	0.62		0.75	
p-value: T-test	0.78		0.35	
Difference in post intervention values				
p-value:Wilcoxon				
p-value: T-test				

Effect of windows

In Kajiado, although the majority of the houses had windows, most of them were very small. In West Kenya, seven had no windows, but there was an external door. All houses had their windows enlarged, and where appropriate they were repositioned. A separate analysis showed that windows had no effect in West Kenya can be observed in Kajiado – (see Tables 6.8 and 6.9 pre- and post- results for no hoods). It would appear that the reduction of IAP in the houses without hoods is largely due to eaves spaces.

Social impacts of interventions

For an intervention to be successful, it must be acceptable to the cook if it is to lead to greater adoption rates in the region – the first stage in scaling up. The observations made by the community, both structured and unsolicited, were recorded by the staff in field notes from focus group discussions and individual interviews.

Poverty alleviation

The project has alleviated poverty in the project homes both directly and indirectly. This has been achieved through: -

- Changes in life patterns as kitchens can be used more effectively
- Increased income through training of artisans to make and sell interventions
- Use of stoves, and windows providing light have given household members more time to engage in other economic activities such as pottery, basket weaving, beadworking, collecting medicinal plants and leisure activities.
- Reduction in cost of kerosene for lighting
- Reported savings in time and money spent in hospitals with burns, coughs, eye, and chest pains.
- Reduced losses caused by attacks on domestic fowl by wild cats, due to grills/mesh on window.
- Reported reductions in common diseases and complaints
- Increased social capital; project women have reported more visitors in the kitchen and more willingness to welcome visitors in the kitchen.

Project women report more visitors in their kitchens (photo: ITDG East Africa)

Empowerment

- Women have gained confidence in decision making on house and kitchen improvement, intervention designs and installations. They have organised group meetings on their own to discuss the indoor air pollution reduction benefits.
- The beneficiaries have been empowered through involvement in design, development and production of desired interventions.
- An increased confidence of project participants through participatory training was noted by the project staff.
- The group members feel their status in the society has been raised as other community members keep sending requests to the respective representatives.
- Project participants at the community level have been empowered to disseminate project outputs through e.g. exchange visits, carrying out demonstrations and installing interventions (e.g. improved cook stoves) with their sub-contracted artisans who can install windows, chimneys and eaves paces for interested households.
- The Kenyan project team was empowered during the project by the transfer of statistical work to the Kenya office from initial management in the UK.

Gender impact

The project targets women and children but the whole family benefits. Both men and women were involved in the project at all levels.

- Women felt more confident through disseminating knowledge to their neighbours
- Husbands became supportive of their wives' initiatives when they realised how much the comfort of their kitchens' were improved
- Interpersonal relationships built up among the women as they worked on the project

In Kajiado, women provided unpaid labour; participated in project meetings/discussions; determined the position/location of the windows and chimneys/hoods and assisted in hood design. Culturally, among the Maasai community members, it is the women who are involved in house construction. However, when the men saw the improvements and the benefits derived by their families they started helping out in the construction of interventions e.g. buying water, windows, cutting trees/twigs, mixing mud, paid for cutting of poles for repairs during window installations. They can now stay in the kitchen, a place they previously used to avoid because of indoor air pollution, and entertain their friends and take beer in the greatly improved environment.

In Western Kenya, men paid for window construction and installation while others offered artisanal skills. Generally, the men in this region are involved in house construction while the women are involved in house maintenance (smearing, installation of improved stoves, positioning and size of windows, eaves spaces).

Spouses now spend more time in the kitchen in West Kenya, sitting by the fireplace while women work, and eating food there, provided the children have left. Occasionally men will assist in the kitchen, which was not a characteristic phenomenon before the interventions were installed. The observations below describe the benefits highlighted by the community members themselves as a result of the smoke interventions. Box 6.1 is reported in the field notes in West Kenya.

Improved health

- Coughs, dizziness and chest pains relieved
- Reduced sweat and heat, so better sleep
- Less headache, malaise
- Reduction in aching eyes, tears and running nose
- Safer - smoke hood acts as a shield, preventing children and goats falling onto fire
- Snakes and rodents cannot hide in the house where there are windows
- Food free from soot contamination

Box 6.1: Reported health improvement
According to R, the husband used to suffer from asthma attacks therefore never used to go to the kitchen but after the interventions were put in place, he is now willing to assist her in some domestic jobs. Nowadays, he normally wakes up at 5.30 a.m., puts his bathing water on the fire then goes to bathe as he leaves the tea getting ready on the fire. The woman is now relieved from waking up early and doing all the household chores by herself

Improved environment and comfort

- Smoke removal
- Improved lighting and visibility through window installation
- Smell removal
- Fresh air circulation
- The hood prevents rain getting onto the fire when the roof leaks
- Men can drink beer in the cool of the house
- Introduction of new ideas: e.g. creation of more space, improved fireplace, introduction of cupboards

Child doing homework using natural light
(photo: Nigel Bruce)

Increased opportunity – income generation

- Able to sew clothes and do beadwork in the house when weather unsuitable out of doors
- Reduction in time lost through ill health
- Improved children's grades at school, as they can work indoors

Woman doing beadwork using natural light *(photo: Nigel Bruce)*

Reduced expenditure

- Reduced kerosene use due to reduced need for lighting (quoted by one householder in Kajiado; 4litres now purchased monthly instead of every two weeks by another)
- Cooking is possible using daylight through the windows
- Food stays longer without spoiling
- Can find lost items
-

Reduced drudgery

- Less soot on walls, ceilings, hair, sheets, children's books, clothes
- Easier to wash the children and do the housework
- Fire cooks faster, is easier to light, uses less fuel and can use any type of wood with smoke hood, so faster to collect.
- Can stay longer in the house (this allows tasks to be completed more quickly)
- Able to watch over calves through the windows

Negative impacts

As with any innovation, there were some negative impacts, which have been, or will be, addressed. These included:

Technical problems

- Some people felt that the kitchens are, at times, cold and draughty during inclement weather
- All the windows were made to a standard design, as this was the most cost-effective way of doing it. Some house owners would have preferred different sizes of window
- Cats could enter through the window – the cats were prevented from entering by having mesh on all windows and eaves spaces
- Leakage around the base of some of the chimneys during heavy rain – so flashing is required
- Wick lamps blow out if the windows are left open when it is very windy – so windows need to be closed, or hurricane lamps purchased

Social factors

- Some women were initially reluctant to communicate problems as they were enthusiastic to allow the project to progress unhindered
- Some people felt that thugs, sneak thieves, and peeping toms could see into their houses. Others feared it would infringe on their privacy. This was to some extent prevented by having shutters on the windows
- One cook observed that chimney hoods made it more difficult to lean over the pot to cook – however, during discussions, she agreed that she would probably get used to it.
- The smoke hood obviously takes up quite a lot of space. Women were consulted as to its position, in order to minimise this constraint
- It was assumed that there are more flies and mosquitoes when there is less smoke. However, in West Kenya the opposite was observed, as the increased air movement in the kitchens kept the mosquitoes away.

Financial aspects

The cost of the intervention was a critical factor, as the households in the study are mainly on a very low-income. The project in Kajiado footed the whole cost, due to the extreme poverty in the area, although some materials and labour were supplied by the households. In West Kenya, a cost sharing element between the household owners and the project was feasible, with about half the cost provided by the household, and also because most of the husbands were willing to provide artisanal skills in installing the interventions. The cost sharing aspect was geared to ensuring sustainability of the smoke-alleviation methods, as described in (Box 6.2).

Box 6.2: Financial arrangements in West Kenya

Discussions were held and an agreement reached with the household owners of what ITDG's contribution towards the interventions will be and what theirs will be (cost sharing element). For example, if two windows are required, ITDG contributes one and they contribute another, if three windows are required, IT contributes two of them. The windows would have wire mesh so that they can open at night while they are cooking. For the eaves spaces, ITDG contributes the wire for preventing other animals from getting into their kitchens. In all cases, they each provide a person to build. In cases where an Upesi stove is needed, the household contributes in full. The cost-sharing schedule was acceptable to all households except for three, who said they were constrained with hunger, school fees and other financial problems and thus treated differently. Most of the houses would have eaves and windows except for specific cases such as HH09 where a hood was recommended.

Financial problems
Money to purchase the materials was scarce, and expenses incurred in installation of interventions caused by the cost-sharing element were a problem. In West Kenya, though the cost-sharing arrangement was important in terms of sustainability, it did mean that some people who would have preferred smoke hoods elected to have windows instead. This may have contributed to the smaller uptake of smoke hoods in this region, as they are more expensive.

Collaboration between project team and community

Throughout the project, there was a good rapport between the community and the project team. Excerpts from the field reports in Box 6.3 reflect the collaborative nature of the work.

Box 6.3: **Collaborative activities between project team and community**

…The women in Kajiado have been very hospitable throughout the study since they spare time for the project staff. Most of them always insist on sharing a meal with the project staff especially if monitoring coincides with their meal times e.g. breakfast at around 7.00 a.m.

…NP took up the responsibility of doing the repairs of the demolished parts. She together with her women colleagues shared the task of the repairs which would have cost her a few Kenya shillings. When the Kajiado team was taking internal measurements, NA was busy plastering and filling the gaps.

…The women thanked the team for everything including the incentives (sugar, tea and flour) during the hard times especially because of the drought experienced during the interventions, and promised to give the necessary assistance to make the project a success. The meetings were usually closed with a word of prayer by the women e.g. in one meeting, NO offered a word of prayer before the participants were released.

Dissemination at community level

- Some of the project families have already expressed a need for more interventions (windows and smoke hoods) in their main/living houses – this will provide employment for the artisans who have been trained by the project. The project women have requested training by the team on how to go about with dissemination of interventions where they will be acting as the key lead.
- Members of the women's groups who were not involved in the project have made representation that they had not been trained on indoor air pollution extraction

techniques. They have suggested training local artisans (among the community members) to ensure sustainability.

- Neighbours of the women involved in the project feel that a bigger group needs to be targeted to meet the demands of the community – this will be addressed in future project work.
- The improvements have prompted several inquiries from neighbours of the household owners. One of the husbands, for example, has had many visitors inquiring about the chimney installed in his kitchen and the improved fire efficiency realised from the improved cook stoves.
- The Kenya office has used the national press to highlight the dangers of indoor air pollution, and to describe the project activities. It will now be seeking to inform the general public through this medium.
- Videos have been made in both regions, and these will be useful dissemination tools, allowing the women to discuss their own impressions of the changes which the interventions have made to their lives
- The project has shared experiences with Institute of Cultural Affairs of Tanzania (ICA - TZ), that was developing a proposal working with the Maasai community in Tanzania. The Institute had been referred to ITDG by a donor, and it is anticipated that this may lead to future collaboration.
- The project has hosted an exchange visit by a team from Munduli district in Tanzania, GTZ - Kitui and Kisii districts.
- The smoke team will consult with the Maasai Integrated Development Partnership Project (MIDPP) on their Urban Livelihoods and Shelter (ULS) Programme.
- The project has worked with Cross-border Bio-diversity project in their planning sessions, and has influenced the project to involve ITDG in the energy component on conservation of energy at Namanga Hill, Kajiado district
- The project has liaised with the local office of AMREF
- The project has influenced the Ministry of Health (MoH), Ministry of Culture and Social Services (MOCSS), and Maendeleo ya Wanawake (an organisation set up to empower and improve the status of women) to participate and to campaign for indoor air pollution reduction.
- Local leaders have been involved in indoor air pollution reduction campaigns

Chapter 7: Key findings on project methodology

The project set out to identify ways in which indoor air pollution could be effectively be alleviated in people's homes. This chapter describes key aspects of the project methodology which were essential for its success, and highlights those areas which proved to be problematic for the benefit of others working in this field.

Household selection

There was no shortage of people wanting to take part in the project. Using the women's groups as the basis for identifying houses proved very satisfactory. A participatory approach, which gave the responsibility of selecting households to the communities involved, meant that everyone was satisfied that the correct houses were being monitored

Carrying out a baseline assessment

Pollution and exposure measurement

The protocols adopted by the project enabled the team to record the unacceptably high levels of PM_{resp}, CO and PCO experienced by the communities. A fundamental constraint is that no universal protocols exist for measuring these variables, so these figures must be regarded as indicative rather than absolute. It should be noted, though, that these values reflect an order (or two) of magnitude greater than commonly accepted norms, and this would be the case even if the monitoring equipment had been sited at any realistic position relative to the fire.

Fuel use and house structure

The protocols addressed the quantity and type of fuel used most often by the study household. In future studies, determining the type of fuel used on the day of testing would allow a more rigorous statistical analysis to be performed on fuel as a confounding variable. In this study, analysis of the pre- and post-intervention results reflects no major change across each community in the type of fuel being burnt.

The houses were characterised during the baseline survey by whether they were already improved a lot, a little, or not at all. This proved somewhat subjective and it might be useful to have a 'points' system to characterise the level of improvements. However, the teams provided excellent sketches, showing the positions of key components, such as doors, windows, stoves, both before and after the interventions were installed. key questions reflected the number of windows, eaves spaces, roofing etc. which might affect the smoke levels in each house.

The enumerators were asked to record the number of hours spent, and the number of times that people collected fuel. This was found to be a rather broad classification, and future studies would try to calculate the total fuel used more accurately.

Identifying participatory ways of alleviating indoor air pollution

This aspect of the project was vital to its success. Women's group discussions allowed the field team to identify possible acceptable and appropriate ways to alleviate smoke. The community were empowered to find their own solutions to their problems, which were realised through manufacture of the interventions in collaboration with the local technical college in Kajiado, and with local artisans in West Kenya– thus providing sustainable skills in the region. The value of committed and enthusiastic local field teams, working with communities who were keen to be involved throughout the process, cannot be over-emphasized.

Monitoring methods

The monitoring methodology is a compromise between obtaining sufficiently accurate results and not intruding too much on the lives of the women involved in the study. The latter aspect is vital, or the results will not reflect the usual day-to-day activities of the woman herself. The method used proved adequately sensitive to change, since the project was looking for

substantial reductions in indoor air pollution, in order to impact on the quality of life of the cooks and their families.The methodology provided a reasonable balance between accuracy and the low levels of disruption to household routine needed to make the results meaningful.

However, one constraint is the lack of 'real time' data – at the project design stage, this type of data is both expensive to procure, and more intrusive for the cook. However, without this data, it is difficult to know how and when the cook inhales the major part of her total daily dose and some real time data would strengthen any further research considerably for the following reason: If the major part of the smoke she inhales is that which is coming directly off the fire when it is being lit, then provision of windows through which the smoke can leave the room once it has spread away from the fire will be much less effective than a hood or eaves space which prevents the smoke getting into the room in the first place.

The time period for monitoring was selected as 24hours, measured during one wet and one dry season. Since many of the women sleep in the same room as the fire, this was essential to capture her full exposure to indoor air pollution. A specific height and distance from the fire was selected, as the spatial distribution of concentrations would otherwise affect the 'before and after' nature of the study. Ideally, the results would be a lot more powerful if they could be compared to other studies being done using the same protocols. Currently no standard testing procedure has been agreed, though this may change in the forseeable future.

Problems and constraints

Technical problems

The study has been carried out in two phases to assess the impact of the project: the pre-intervention and post intervention monitoring periods. In the pre-intervention period, three rounds of monitoring were needed in both areas to capture information that was inconclusive during the earlier rounds of monitoring.

Equipment

The equipment was chosen to be as discrete as possible, for the reasons described above. However, the power supply for the air sampler was working close to its limits, and replacement of the battery pack with a standard car battery and adapter (locked securely in a wooden box) proved more successful towards the end of the project. This battery also meant that the teams did not have to recharge the PM_{resp} sampler every night, so proved less stressful on the team.

In Kajiado, the high levels of indoor air pollution meant that some of the first round of monitoring was inconclusive. The solution was to change the filters and CO monitors after six hours during the day, and over twelve hours through the night. Nevertheless, the equipment became very dirty and contaminated very quickly, therefore required regular servicing.

Initial charging of the monitors in Kenya proved unsatisfactory due to climatic conditions. The pumps erroneously recorded that the built-in batteries were fully charged, with consequent failure in the field. This problem is now resolved by using the car battery.

Monitor height

The first round of sampling was conducted with the PM_{resp} and CO monitors set at 4ft height and 4ft distance from the fire. Following an external review which advised that monitoring at 2.5 feet would aid comparative studies with other indoor air pollution projects (4ft and 2.5ft are currently used by other practitioners), the suggestion to use 2.5ft was adopted for the second round of monitoring in West Kenya. The change only became evident to the rest of the team once the results from the monitoring came from the field. As it was not feasible to monitor every house again, a sample of kitchens was monitored at both 4ft and 2.5ft, and two height monitoring was used in the post-intervention rounds.

Recording data

It is important to know exactly what decisions are made by field staff on replacement of filters etc. when low values are recorded. If staff do not replace filters etc. every time, there is a risk that the mid-sampling value and the final value are added, rather than just the final value

taken. These records should form part of the monitoring sheet filled in during the monitoring process.

Installation
Despite the hoods being in two sections, there were problems in getting them into the kitchens in Kajiado, due to the geometry of the house. This could be a factor in scaling up this type of intervention, as it requires more than one person to transport and install the hood.

Installing both hoods and windows is both time-consuming and strenuous. A lot of dust and soot is disturbed, so protective clothing must be worn. Installing the interventions into new buildings would be considerably easier.

Leader of West Kenya field team calibrating equipment before taking to the field *(photo: Nigel Bruce)*

Field work

Training
Prior to field work, the team was given training in monitoring and field techniques. The importance of the team understanding why they were making specific measurements or asking particular questions cannot be overstated.

The arduous nature of the field work under field conditions are highlighted below:

Unseasonal weather
In some areas of Kajiado, such as Oloosuyian, people had been forced to migrate to other neighboring areas (Machakos, Nairobi, Thika, and Keroriti near Namanga). Meetings were therefore dictated by the household's availability. In addition, some interventions were delayed because some of the household owners had moved away with their livestock.

Torrential rains when there should have been dry weather in the first post-intervention round (see field report – Box 7.1) meant that the final monitoring in Kajiado had to be done when the weather was just turning towards the expected rains. However, the team ensured that all the testing was done at a time when there had not been sustained heavy rain, so the fuel could be expected to be reasonably dry.

Box 7.1 - General situation during the post intervention monitoring
When the post intervention monitoring was conducted from 13th November up to 14th December 2000, the area had been hard hit by drought in the previous months therefore livestock had died in large numbers which was evidenced by the gaping skeletons across the land. Due to this calamity, most of the pastoralists were forced to move to other areas in search for greener pastures in the neighbouring districts such as Machakos, Nairobi, Namanga region and some Northern parts of Tanzania. In addition, the food surplus in the area had declined so much that the community mainly relied on relief food (maize).

Rains began in mid November and the community members were hopeful that the weather would go back to normal and ultimately some household owners had started returning home by the end of November to early December.

Travelling to the field
In both Mumias and Nyamira, the distances covered were considerable; the roads were in bad condition, especially during the rainy season, and in instances when the pumps were

troublesome, it meant visiting households late in the night. Scheduling to have start times and ending times corresponding with sunrise or sunset proved more convenient for both the households and the monitoring team.

Unreliable electricity supplies
Electricity power cuts, or no access to grid electricity at all, caused great difficulty in charging the batteries for the sampling pumps. This problem was alleviated towards the end of the project by using a car battery and adapter.

Social aspects

Local field staff
A key aspect of the success of the project was that field staff were already well known in the region; some of the field staff belonged to the communities with whom the project was working and were thus able to speak in the local language.

Determining the name and address of the cook
In Kajiado, women were known by different names, moved house within the area, and cared for different numbers of children. As the houses do not have any kind of recognised 'address' it was important to ensure that the cook was still living in the same house for each round of the study. This situation is likely to occur wherever the community is relatively mobile and where households are widely dispersed.

Determining the age of the cook and her children
Determining the age of the women and their children was difficult since it was not something which mattered to them, so they did not remember unless they produced their national identity cards or they related their dates of birth to certain historic events. In determining the age of the children, most women would relate better to the classes their children are in at school, and the monitoring team would estimate the age.

Health
In one house, a new baby had been born, and culturally this required both mother and baby to be confined, with all the windows closed and the fire alight throughout. In another house, a woman was ill during one round of monitoring. Field reports are given in Box 7.2. The situation was further exacerbated by heavy rains and cold weather, which persuaded her to keep the windows closed. As a result, the fire was on all day, and she was resting beside it. In both these instances, the levels were not representative of the day-to-day levels in that house.

Box 7.2: Monitoring in HH45

- The monitoring team went to HH45 on Thursday 16th November 2000 to inform her of the post intervention monitoring that was to start the following day. Unfortunately, S. and her husband were both ill and therefore they requested to be taken to Kajiado District Hospital. On being taken to hospital the physicians diagnosed S. and said she was suffering from Malaria while the husband was suffering from cancer of the leg. After the treatment, the couple was returned home to rest and the team was to go back once their condition was better.

- On the morning of 18th November the team went to start monitoring the house but this was not possible due to a heavy downpour making the road impassable especially because the Ol-Kejuado river transverses the road to this home. The team went back in the evening and was forced to leave the car next to the river since the car would be stuck in the mud. From there people had to trek for about 20 minutes to reach the home. The monitoring equipment was fixed at around 18.30 hours so that ample time would be left for the monitoring team members to get back to the car before dark. 12 hour readings were taken the following morning at 06.30 hours while the other readings were taken in the course of the day for a complete 24 hour cycle. The strange thing that was noted was the fact that 3 room tubes and 3 personal tubes were used throughout the study because the woman who was still sick was confined indoors and the fire was alight all through the 24 hour sampling period. Her bed was very close to the fire as compared to the distance between the fire and the other monitoring devices. She told the team that her house was very cold due to the heavy rains and therefore she tried to keep it warm by lighting the fire throughout the night and also keeping most of her windows shut.

Questionnaire design

The questionnaires were developed in consultation with staff in the regions. They have two roles: to provide an overview of the lifestyles of the people involved; to identify any changes that have taken place during the project. There are several key elements that need to be addressed in these questionnaires:

- How will the question be put to use at the end of the study?
- Does the question have the same meaning to field staff and community as it does to the staff who produce the questionnaires?
- Do we need to know , in general, about the lifestyle of the person, or do we wish to correlate data with the measurements of PM_{resp} and CO for the day that household was monitored? In the latter case, the questions must relate to the day on which the monitoring was done
- Care must be taken that every reasonable eventuality is addressed (e.g. there was some confusion about mealtimes for those people who only eat two meals a day).

Loss of houses

Three women moved out of their original houses between pre- and post-intervention, which meant that the results could not be used. One house was lost in Shukaa location after the opted for a divorce, which culturally means demolition of a house to signify the disintegration of the unit. For reasons such as these, more houses should be monitored in the pre-intervention rounds than are required for analysis.

Education

People in Nkoile (Kajiado) are very receptive to new ideas, compared to the other regions. This is attributed to the proximity to Namaga and Kajiado town, resulting in a higher level of education.

Identification, installation and development of appropriate interventions

The field teams formed the link between the communities and the whole of the project team. Belonging to, or having worked with, the communities in the area meant that the team themselves had ideas which could catalyse the initial discussions on what would be appropriate. These ideas were distilled into three key interventions. This was vital, as a random collection of interventions, all being installed, would have prevented any kind of analysis on the impact of the interventions. This approach enabled both the communities themselves, and the wider development community, to benefit from the research.

Sometimes extra 'interventions' were made during the study. For one or two of the households, it was found that a wood-rack '*Irongo'* was blocking the smoke from leaving through the eaves spaces. In these cases, the rack was repositioned. These extra interventions need to be documented systematically.

Training and maintenance

Training and maintenance was mainly conducted through women's groups, and often involved other organisations, such as the representative from the Ministry of Health. Aspects of smoke alleviation were incorporated into other health messages. By using group discussion, everyone involved was able to share advice based on their own experience, thus increasing the knowledge-base of the whole community.

Linkages with other organisations

Linkages with other organisations are important as they raise the level of awareness among a far wider group than would otherwise be the case. They also pave the way for future work in-country and in other areas within that country. A further aspect is that the project brings together practitioners from several disciplines, health, finance, energy, technology, business, and their skills can provide a holistic solution in the longer term.

Chapter 8 – Discussion

The main objectives of the project were twofold: to improve the quality of life, through reduction in indoor air pollution, for households in these study areas; and to develop a participatory methodology for further research into appropriate ways to alleviate indoor air pollution. This analyses both the successes and any constraints to success which need to be addressed in future work.

Evaluation of changes in pollution and exposure

Effect of smoke hoods

Smoke hoods were undoubtedly the most successful intervention in terms of smoke alleviation – especially as windows were installed at the same time, which provided a good draught to optimise combustion. Smoke hoods are also good because they work in all weathers. As they are more tolerant than chimney stoves to variations in geometry, they can be made to suit the cook, and still be effective, and can be copied more readily at local level.

In West Kenya, where Upesi stoves and smoke hoods were used in combination, the stove minimises the sparks going up the chimney, increasing safety where the hood is built through thatch.

Effect of eaves spaces

Eaves spaces, though not quite so effective at removing smoke, are an extension of what is happening in several of the houses in West Kenya already – so they are very well accepted. Providing a frame formalises the need to have space behind the stove for smoke to escape. Building in an Upesi stove ensured that the eaves spaces were located at the optimum position. It was noted that some of the household members who slept in the room with the eaves spaces found that it got cold at night. Further work might enable the community to collaborate with the local artisans to provide shutters for the eaves spaces that could be closed at night to alleviate this problem.

Effect of windows

Those houses with windows as their only intervention did not show any marked improvement in smoke reduction, although they had several important social benefits. However, where extraction methods, such as hoods, are in use, it is important for there to be sufficient air coming into the kitchen to 'match' the hot air leaving, and it was observed by both the team and the householders themselves, that combustion improved when the windows were opened.

Effect of stoves

There was no statistically significant reduction in indoor air pollution through using stoves. This is an important negative result, but it is not the only study which reaches this conclusion (Ballard-Tremeer,G. & Jawurek, H.H. 1996).

It has been shown that stoves reduce the need for fuelwood, which might suggest that therefore there would be a reduced quantity of products of combustion. However, the products which are damaging to health are those which are overwhelmingly emitted during the 'heating up' stage of combusion – before the fire reaches a sufficient heat to convert the fuel into carbon dioxide, rather than particulates and carbon monoxide. A three stone fire has an advantage in this respect – there are no stove walls to be heated up during the early stages, so the fire can become hotter sooner. Thus for a fire of short duration, a three-stone fire can be a fairly efficient option.

This, however, is the only advantage of the three-stone fire as much of the heat is then dissipated and is not directed at the pot. Thus the 'benefits' of the three-stone fire are counteracted by the need to use more fuel for a longer time in order to get the food cooked. This is especially true where long slow cooking is required – once the stove gets hot, then it is a much more efficient means of cooking. The excellent combustion characteristics of the Upesi stove mean that for the types of meals cooked in West Kenya, this stove provides

overall advantages in terms of cooking time, and fuel efficiency and does not increase the level of emissions. It is also safer, cleaner, and increases the prestige of the cook.

It should be noted that recent studies showing reduced indoor air pollution using stoves (Ezzati, M. Kammen, D.M., 2001) involve the use of charcoal stoves rather than stoves burning the same fuel as the three-stone fires, and it may be that the improvement is caused by fuel change rather than stove use. In the communities in West Kenya, it is unlikely that a complete change to cleaner fuel would be acceptable as residues are available 'for free', whilst charcoal has to be purchased, even though, in some of the houses, charcoal was burnt in the main house for heating rather than cooking.

Community perspectives

Throughout the project, the field teams were made welcome by all the households taking part and were often invited to share a meal. The very high percentage of households staying with the project reflects the level of ownership felt by the communities for the project, and the skill and sensitivity of the field teams. There were minor problems which should be identified.

- Asking the times at which particular meals were taken made one family cook extra meals, just to provide the data required. Though this reflects the loyalty of the cook to the project, it is regrettable that she had to make the extra effort.
- Some of the husbands felt that their wives should have been paid for the time taken to attend meetings

Community views on acceptability and affordability of interventions

Acceptability

The overwhelming feedback from the community members is that the alleviation of indoor air pollution has far exceeded their expectations and a major reason for this is the participatory nature of the project. The marked decrease in smoke and increased well-being associated with this reduction were reflected in many of the formal and informal comments made to the project teams. Nevertheless, there are outstanding concerns which need to be addressed (improving privacy, ensuring that eaves spaces can be closed in very inclement weather etc.)

Affordability

Affordability remains a major constraint to indoor air pollution alleviation. There are positive signs that, in the case of some of those living in the nearby communities, the realisation of the benefits has made them re-evaluate the cost of the interventions. Of particular note is the interest taken by the men in the communities. They are the ones who, on the whole, are in control of household finances. Having been involved in installing the interventions, it is positive to note that they are discussing interventions in terms of the comfort value of a less smoky environment. Reports from the field suggest that people are now asking how and from where they can obtain hoods and windows. Entrepreneurs to promote, manufacture and supply these interventions will form part of future work within the project areas. Funding is actively being sought to provide this next phase in scaling up.

In Kajiado, the project families were not asked to contribute to the cost of the interventions. Smoke hoods, which cost the equivalent of the cost of two goats, are deemed expensive, especially if it is only the women who benefit from them. However, the men in the Maasai community are expressing interest in the increased comfort levels in the homes with smoke hoods, and if they decide that the hoods should be installed, it is likely that this intervention will be widely adopted, since they are the ones who control most of the family income. Reducing the cost of hoods by using cheaper, but effective, materials, or seeking a subsidy, comparable to that provided for vaccination on the grounds of health, could further increase the prospects for smoke hoods.

In West Kenya, cost-sharing meant that there was strong evidence that households were willing to part with money, reflecting their level of commitment to the need to remove smoke. However, the adverse effect was that some households chose the less-costly option of eaves spaces – still effective, but not so effective as the smoke hoods they might otherwise have installed.

Empowerment of communities

Making communities aware of the risks associated with household smoke
Empowerment through knowledge is among the most cost-effective ways of improving the quality of life for those with few capital resources (Tim Allen; Alan Thomas (eds.), 2000). The participatory approach has been very powerful in addressing this key aspect of poverty alleviation. Engaging with the cooks in every aspect of the project has made them keenly aware of the risks to which their families are exposed, and has empowered them with the means to do something about it.

Members of the field team have been requested by other members of the women's groups to be kept informed on what is being done in the project. Some of the women have described to the team their feelings of responsibility for passing on the knowledge to others in their community – this has increased their social capital within the community.

Empowerment through enabling mechanisms for alleviating smoke
Poverty leaves little time or resources for dealing with tasks outside the day-to-day activities needed for survival. In this project, women's voices were heard, their advice was taken and acted upon, and their ideas were scientifically tested. This approach, balancing local skills and knowledge with technical monitoring, has ensured that the interventions which will be further disseminated are both acceptable and effective. This has empowered the community to help provide the solutions to its own problems.

Development of a national strategy for dissemination and sustainability

These results, showing a very positive impact on the families with interventions, allow proven information on interventions which are both effective and well-accepted to be disseminated within communities with similar lifestyles in the regions. These initiatives are discussed further in Chapter 8.

Exchange of experience internationally

Internationally, the work has been disseminated through:

Conferences
- Gitonga, S.; 'Addressing the indoor air pollution and household health problem in Kenya' at *USAID/WHO Technical Consultation on Health Impacts of Indoor Air Pollution in Developing Countries, 3rd to 4th May 2000, Washington, USA,* May 2000*,*
- Gitonga,S.: 'Simple Interventions to Improve Children's Health by Reducing Levels of Indoor Air Pollution - Case of East Africa' at *Children's Environmental Health (CEHN) II: A Global Forum for Action* Washington, USA, September , 2001
- Bates, E. et al: 'Improving air quality in Rural Kitchens in Kenya' at *International Conference on Biomass-based Fuels and Cooking Systems (BFCS-2000),* Pune, India, November 2000

Journal articles
- 'Safe as houses?' in *Small World, Issue 31, March 2001*
- 'Best choice for better households' *ITDG Eastern Africa Newsletter,* October 2000
- Bates, E: 'Smoke, Health and Household Energy – the link' in *DFID Energy*, November 2001
- Gitonga, S. 'Case study: Achieving Sustainable Reductions in Indoor Air Pollution and Improving Health through Participatory Community Technology Development in Rural Kenya' in *Energia News*, December 2001
- Bates, E. 'Smoke can seriously damage your health – especially if you live in the developing world' in *The Woman Engineer*, Spring 2001

Reports

- Doig, A. Indoor Smoke Pollution and Household Health; Reducing Smoke Exposure in Household Dependent upon Biomass Fuels: *ITDG Report* on First year May 1998 – April 1999
- Doig, A. Bruce, N., Bates, E. Indoor Air Pollution and Household Health: The Smoke Problem: *ITDG Interim Report* July 1999
- Doig, A., Bates, E., Bruce, N., Gitonga, S. Indoor Smoke Pollution and Household Health: Reducing Smoke Exposure in Household Dependent upon Biomass Fuels: *ITDG Report on Second Year* May 1999 to May 2000
- Kenya Smoke and Health Project 1998-2001, *ITDG Final Short Report*, December 2001

Networks

- Bates, E. 'Reducing smoke, improving lives' a case study from Kenya' *in Technology for sustainable livelihoods* website – case studies section at : *www.livelihoodtechnology.org*
- Proposed future international dissemination of best practice is described in the next chapter.

Development of a replicable participatory methodology for indoor air pollution alleviation

This methodology will form the basis for future ITDG work in international comparative studies – see next chapter. As a pilot project, this work enabled the team to test the methodology and protocols and identify shortcomings and improvements for future studies. Many of these findings have appeared throughout the text, but will be listed briefly below for convenience:

- This type of project should be participatory at all stages, and include key actors from the community including the household members, local authorities, artisans, health professionals etc. and an integrated project team.
- There is a pressing need for key technical aspects of the protocols to be standardised if findings are to be compared across projects. These aspects would include: the time over which the monitoring took place; the position of the monitors; the meaning of terms such as 'personal CO' ;types of fuel; cooking times; recording interventions; etc.
- Overall, the questionnaires reflecting household and house characteristics provided a good insight into those aspects of community life which have a direct bearing on energy use. However, it should be noted that these protocols were designed in consultation with teams who were working in the particular communities, so that the questions were locally appropriate and culturally sensitive.
- The 'before and after' nature of the project meant that certain changes took place which could not be avoided – weather, number of people in the household, availability of food and fuel etc. For more rigorous analysis of these confounding variables, it might be considered more effective to identify what the household uses by way of fuel and food on the day of monitoring, rather that seeking to identify what they identified as their staple requirements (e.g. dried maize distributed during famine will affect cooking time, but is not in the usual diet of the Maasai community). This, however, might make it more difficult to characterize the lifestyle of the community. Care must be taken not to overload the individual householder with questions – only those questions should be asked which can realistically be part of the overall analysis.

Chapter 9 – Future work

Local level

At the time of publication (January 2002), he project team in Kenya is actively seeking funding for follow-on work to scale up those interventions which have proved most successful. Scaling up activities which have been identified include:

- Working with other NGOs such as AMREF, and local government offices, to provide support for dissemination and further installation of smoke-reducing interventions
- Dissemination through extra women's groups, health centres, schools
- Forming committees on smoke-free environments
- Forming health committees on environmental health at village level
- Running capacity-building workshops for artisans manufacturing devices for reduction of indoor air pollution
- Introducing a child to child programme on indoor pollution campaigns
- Running workshops on indoor air pollution study findings, and community awareness

International level

The findings from this project will be disseminated through:

- International conferences, including;
  - Bruce, N. et al: ' Reducing indoor smoke pollution through participatory technology development in rural Kenya' to be presented at *Indoor Air 2002,* Monterey, USA, 2002
  - Doig, A.: ' Household Energy, indoor air pollution and health – experiences in Kenya' to be presented at the World Renewable Energy Congress, Cologne, Germany 2002
- Further dissemination through journals, including *Boiling Point* and through websites, including the HEDON website

One aspect of the project was enable ITDG to evaluate the success or otherwise of a participatory approach to smoke alleviation. The methodology has shown itself to be very effective, and a similar approach will be adopted in a new project, funded by the UK government Department for International Development. This project will involve communities in Nepal and Sudan, as well as looking at the urban context in Kenya. It is hoped that the three-country project, currently funded, will lead directly to a scaling-up phase and enable the lessons learnt to be applied on a sustainable and commercial footing. Funding is currently being sought towards this end.

Funding is also being sought for scaling up successful interventions within Maasai communities in Tanzania and Uganda.

Annex 1: The scientific process

Study methods

The overall study employed a 'before-and-after' comparison in the two study areas. One year of baseline monitoring followed by interventions over 6-9 months, then a further year of follow-up monitoring (total 2.5 years).

This design was judged most appropriate given the participatory nature of the development work, which would have made use of parallel control (non-intervention) areas very difficult to justify and maintain. Although this design left the study open to influences other than those implemented by the project, the methodology was deemed to be appropriate in communities where changes evolve slowly. The range of other factors that might influence pollution levels and exposure were measured during the course of the study, and changes over the course of the project assessed. In addition, the assessments of pollution and exposure were repeated twice per year both before and after the interventions, to allow characterisation of within-house variation across the wet and dry seasons of the year and more precise estimates of the true effects of the interventions to be obtained.

Sample

A total of 50 houses (25 per area) were sampled. The criteria for sampling were that:

- the house structure should be typical
- the family were interested in the project objectives,
- they should be prepared to accept the questionnaires and monitoring over the 2.5 years of the study, and
- they should be keen to implement changes to the homes in consultation with ITDG staff
- the households should preferably include children aged under five years, as these are the households where women spend most time in the kitchen

Although it was recognised that this was not a random sample, the houses selected were considered to be typical for the communities involved.

Pollution assessment

Particulates

Particulates: 24 hour respirable particulates (approximate aerodynamic diameter 5 microns or less) were measured in houses using a Buck I.H. pump sampling at 2.2 litres/minute, a Higgins-Dewell type cyclone and 35 mm glass fibre filters (Whatmann) – this equipment conforms to BSEN-481 for inhalable thoracic response.

The pumps were calibrated using a Munro RM1069 rotometer prior to each sampling period. The cyclone was placed at 4 feet above the floor of the kitchen, and 4 feet horizontally from the hearth (in Maasai kitchens it is typically difficult to exceed this distance due to the small size of the room). Due to the very high levels of pollution, filter cassettes were changed after 12 hours to avoid clogging. The equipment was designed such that, if the sampling flow rate dropped by 5% or more, the Buck pump sampler suspended air sampling, and recorded the elapsed time and volume sampled before shutting down.

Carbon monoxide

Carbon monoxide (CO) was measured in the kitchens using Gastec 1D (1000 ppm/hr) diffusion tubes co-located with the cyclone. The purpose of this is twofold:

- The main purpose was to allow the use of CO personal exposure assessment (see below) as a proxy for PM_{resp}, as this avoids the use of cumbersome personal pumps which seems certain to interfere with normal daily activities. This method of exposure assessment is similar to that used in recent studies in Guatemala, and has shown promising results with correlation coefficients between room 24 hr integrated $PM_{2.5}$ and CO in excess of r=0.9 (Naeher, '96).
- The second reason for measuring CO was the potential for direct health effects of what appear to be very high levels in the kitchen.

Up to three tubes were used during the 24 hours, depending on the levels of pollution.

Personal exposure assessment

CO level

Twenty-four-hour integrated CO exposure for each cook was measured using a Gastec 1D 1000 ppm/hr diffusion tube. This was placed in a holder and clipped to clothing on the left upper chest. The woman was asked to place the tube/holder near her head when sleeping. Generally one and two tubes were used during the 24 hours depending on the levels of pollution (in one instance three tubes were used when the woman was ill and indoors all day).

Time-activity assessment

The index woman was asked to recall her activities, and those of the three youngest children who usually live in her house, for the same period as for air and personal sampling. To aid recall, the day was divided up into hour-long periods. The purpose of this assessment was::

- To provide an alternative source of information about exposure
- To allow interpretation of personal CO levels before and after the interventions, which are influenced by both ambient levels of pollution, and the time spent in polluted and environments. Both of these factors could be altered by the intervention: thus, reduced room pollution levels may not result in lower human exposures if the women and children 'compensate' by spending more time in the home.
- To provide information on the exposure of young children.

Data collection

Information on the household, house construction (windows, doors, ventilation), stove type, fuel used for various purposes, and cooking (foods cooked, numbers cooked for) during the air/personal sampling period, was collected in the two areas, using a standard questionnaire developed for the purpose. Symptoms of chronic obstructive lung disease (COLD) among the index women were also assessed, using a questionnaire developed by the Medical Research Council, with minor modifications to allow for local symptom terminology and seasonal patterns. In view of the relatively small sample size (n=50), and the nature of the sample (non-random), these questions were included only as an initial exploration of the extent of COLD in these populations. Symptoms of eye discomfort were also reported.

Laboratory methods (filters)

Filters for gravimetric analysis were prepared using standard procedures, in the Department of Analytical Chemistry, University of Nairobi. The filters were dried, and then weighed on a 6-place balance, prior to insertion into the cyclone cassettes, labelling and despatch to the field. On return from the field, the filters (still in cassettes) were dried, and then re-weighed. Regular checks were made on calibration of the balance, and laboratory blank filters used to check quality control.

Field supervision and quality assurance

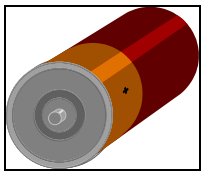
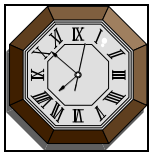
Each of the two field teams had a supervisor who was responsible for preparation of the questionnaires, CO tubes, filter cassettes and air sampling equipment (charging and calibration) for each house visit. The supervisor directly observed approximately 50% of household assessment (air sampling and questionnaires). Around 10% of questionnaires were repeated independently by the supervisor. On return from the field, the supervisor re-checked and recorded the stored pump data (time elapsed, volume sampled, flow rate). The room and personal CO diffusion tubes were sealed at the end of the sampling period, and re-read blind by the supervisor (for analysis the mean of the field worker and supervisor readings was used). A proportion of filters prepared in the laboratory were used as blanks, and returned from the field unused to act as controls.

Equipment and technical support

Equipment was supplied by Munro Group, Gilbert House, 406 Roding Lane South, Woodford Green, Essex IG8 8EY, UK. The representative of this company has given expert technical support and advice to the project team throughout the project.

Annex 2 – Sample pages from monitoring questionnaires

1. Sample page from protocol for preparing equipment

#	Step	Reminder!	Field
1.	**Complete Fields 1-4 of data collection form.**		1 - 4
2.	**Check flow rate of pump:** • Place "practice" cassette in cyclone, and ensure that the cyclone lid is securely tightened to avoid leaks (but do not overtighten). • Connect air flow meter, and ensure on flat stable surface • Switch on pump, ensure pump fully charged (it will read about 107%) • Scroll to sampling mode, and press enter to start sampling. • Allow 1-2 minutes to stabilise, and check whether flow meter (top of red float is level with upper red line, 2.2 litres/minute: ***make sure your eye is at same level as the red line!!***). • Record flow rate from flow meter, before re-calibration If the flow rate is 2.2 litres/min, go on to **Step 4**. If not, go to **Step 3** to re-calibrate the pump.	 Is the pump battery fully charged?	5
	•		
3.	**Re-calibrate pump:** • Change to configure mode. • Clear ***all*** settings. • You may wish to switch the configure security code off at this stage. • Ensure "practice" cassette in cyclone, and flow meter is attached. • Change to sampling mode. • Press enter to begin sampling, and adjust the flow using the UP and DOWN arrows until flow rate is exactly 2.2 litres/min. Use technique as described in Step 2. • Wait until the display instructs you to press "enter", then do so. • Adjust the four digit display to read 2200 cc/min, and then press enter again. • You will be asked whether to activate the keypad lock and configure security code at this stage: it is suggested you do this ***after*** you have cleared the elapsed time/volume sampled display (Step 4).	Don't forget to keep you eye at same level as red line when checking flow meter!! 	
4.	**Clear time elapsed and total volume sampled:** • Change to configure mode. • When asked whether to clear all settings, enter **no** (otherwise you will erase the flow rate calibration!!) • Clear elapsed time (and volume) only?, change to yes, and enter.		

2. Sample page from data collection form (second page)

15.	**Position pump and cyclone:** • Connect cyclone to pump, and ensure cyclone lid securely tightened, and pipes well connected. • Identify site used in pre-intervention monitoring for **cyclone** (In kitchen, 4ft above floor level, at least 4-5 feet from fire, and away from smoke rising directly from fire). ***Please use the same site as used in pre-intervention monitoring*** • Fix pump and cyclone securely. Ensure cyclone is upright.	**Height of cyclone above floor level?**	15
16.	**Switch on pump:** Switch on (press **on/hold** button): pump in **sampling** mode. Record temperature	Temperature = deg C	16
	• Record time of day (24 hour clock)		17
	• Record atmospheric pressure from barometer	Pressure =	
17.	**Begin sampling:** • Ensure that the elapsed time is zero (0:00). If not, you will need to go into **configure** mode and clear the time and volume - see Preparation protocol Step 4. • Start pump sampling (press **enter**).		
	• Allow pump to stabilise, which may take 1-2 minutes. Check: is the flow rate between **2100** and **2300** cc/min ? Enter **Yes** or **No**		18
	If the flow rate is **not** between 2100 and 2300: • *make sure the tubes are not kinked, and are connected securely.* • *make sure the cassette is in the right place, the cyclone lid is securely fastened, and the cyclone inlet tube is not blocked.* <u>If , after checking these, the flow rate is still not within the specified range, the sampling should be stopped and the pump re-calibrated.</u>		
18.	**Start the room CO diffusion tube (Type: Gastec 1D):** • Select plastic tube holder with the **house number,** and **"room"** already written on it. • Break end of tube • Insert tube in holder, and place next to cyclone • Dispose of broken glass end in bag.	**Write in the ID Number of the room tube here:**	

3. Sample page of household questionnaire

Note to interviewer:
This questionnaire is set out in two parts. The ***first*** part should be administered before the air sampling period begins. The ***second*** part is to be administered on completion of the air sampling, and refers to the previous 24 hours - which is the period of air sampling.

PART A: QUESTIONS TO BE ASKED BEFORE STARTING THE AIR SAMPLING

#	Question		Data	Field
1	**Household number**			1
2	**Date of interview**			2
3	**Time of day** (24 hour clock)			3
4	**Name of interviewer**			4
5	**Name of interviewee**			5
6	**Age:** How old are you? [Please enter exact age if known, otherwise enter code number of the appropriate age group, (e.g. 4 for age group 30-34)]: 15-19 (1) 45-49 (7) 20-24 (2) 50-54 (8) 25-29 (3) 54-60 (9) 30-34 (4) 60-64 (10) 35-39 (5) 65+ (11) 40-45 (6)			6
7	**Number of adults usually living in the house**			
	• Males			7
	• Females			8
8	**List details of ALL children usually living in the house, UP TO AGE FIVE YEARS, starting with the youngest.**			
	Child 1(youngest)	Sex: (Female=1, Male=2)		9
		Age: Years and months		10
	Child 2	Sex: (Female=1, Male=2)		11
		Age: Years and months		12
	Child 3(oldest)	Sex: (Female=1, Male=2)		13
		Age: Years and months		14
9.	**What times of day do you usually cook meals?** *(Please enter the actual time of day, spanning the time to cook, using the 24 hour clock)*			
	Breakfast			15
	Lunch (middle of day meal)			16
	Tea			17
	Dinner			18

4. Sample page of house and kitchen characteristics questionnaire

#	Item	Data	Field
1	**Household number**		1
2	**Location/Area**		2
3	**House type: level of improvement** 1- very traditional 2- traditional, minor improvements 3- substantial improvements		3
	If 2 or 3: briefly describe type of improvements:		4
4	**Kitchen type:** 1- part of main house 2- separate building		5
5	**Type of roof:** Others: please specify 1- mud or cowdung 2- ferro-cement 3- Iron sheets 4- Thatch		6
6	**Permanent ventilation in roof** (this includes holes/vents deliberately inserted into roof, <u>other than</u> eave spaces) 1- None 2- Small (less than 3 inches in diameter) 3- Large (more than 3 inches in diameter) 4- Other (describe)		7
7	**Eave spaces:** 1- almost none, or none 2- moderate 3- large		8

Annex 3: Time-Activities Study of a typical Maasai household

Dry Season		
Hour	**Activities**	**Fire?**
12.00	At 12.00 m/n cover fire, put on githiri. 00.30 mother goes to sleep.	
01.00	Sleep	
02.00	Sleep	
03.00	Sleep	
04.00	Wake, light fire, make tea. Milk cows	
05.00	Prepare water cans Take tea	
06.00	Load donkeys	
07.00	Leave for water point	
08.00	Getting water	
09.00	Getting water	
10.00	Getting water, watering animals	
11.00	Watering animals	
12.00	Load donkeys and fill cans	
13.00	Return home	
14.00		
15.00		
16.00	Arrive back at home, rest. Light fire (4.30), prepare tea, wash dishes. Serve children tea	
17.00	Food on to cook, prepare vegetable	
18.00	Serve food for all family members. Collect wood	
19.00		
20.00		
21.00	Boys and girls help with milking. Boil milk and make tea.	
22.00	Prepare supper, then wash dishes.	
23.00	Eat supper, children to bed.	

Wet Season		
Hour	**Activities**	**Fire?**
12.00	Sleep	
01.00	Sleep	
02.00	Sleep	
03.00	Sleep	
04.00	Wake. Light fire, make tea. Take tea.	
05.00	Milk cows	
06.00		
07.00	Clean calf pen	
08.00	Release livestock, clean goat's kraal.	
09.00	Clean house, mend leaking roof	
10.00		
11.00	Light fire to help dry house. Clean calabashes.	
12.00	Separate goat kids from mothers. Prepare to go for fire wood. Feed children.	
13.00	Go to collect wood	
14.00	Collect wood, return 15.00	
15.00	Rest while making handcraft.	
16.00	Go for water nearby.	
17.00	Close livestock in the dock because of rains.	
18.00	Milk cows	
19.00	Separate calves from cows.	
20.00	Family in house and children go to bed.	
21.00	Prepare calabash for next morning.	
22.00	Mother goes to sleep.	
23.00	Sleep	

Annex 4: Statistical method

Sample size and power

The sample size requires to be large enough to demonstrate useful changes in pollution levels and exposure for the two area samples combined, and also for sub-groups as defined by the type of intervention and location.

Based on alpha level of 0.05, power of 80%, pre-intervention 24 hour mean PM_{resp} (respirable) level of 1500 $\mu g/m^3$, standard deviation of 500 $\mu g/m^3$, and reduction to be detected of 33% (to a mean level of 1000 $\mu g/m^3$), this yields n=16 per group for an unpaired analysis, and n=10 for a paired analysis. Paired analysis is appropriate as the same houses were compared before and after the interventions.

The analysis

The main analysis consisted of the following steps:

- Descriptive analysis of house and household characteristics and how they have changed during the project
- Assessment of the mean pre- and post-intervention levels and differences in kitchen pollution and personal exposure overall (both areas combined), and by area.
- Assessment of the pre- and post-intervention difference in kitchen pollution and personal exposure by three broad types of intervention, with (a) both areas combined, and (b) areas analysed separately.
- Analysis of the association between room CO and PM_{resp}
- Analysis of changes in potential confounding factors associated with kitchen pollution and personal exposure levels, such as temperature, rainfall, meal servings etc.

Data handling

Data was entered in Microsoft Access, and all entries were rechecked by a second person.
All data analysis was conducted using SPSS

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Reducing indoor air pollution in rural households in Kenya:

Working with communities to find solutions

ITDG project 1998-2001

It is now accepted that indoor air pollution is one of the major causes of death and ill-health in low-income communities. Those mainly affected are women and children, as they are the ones who are usually in the kitchen when cooking fires are being used. Substantial efforts to reduce indoor air pollution need to be made if the impact on women's and children's health is to be commensurate with the gravity of the problem.

The study described in this publication has addressed the problem using a participatory approach. It is being run by ITDG, in collaboration with the Department of Public Health, University of Liverpool and the University of Nairobi, Kenya.

The project has found appropriate and sustainable ways to reduce smoke substantially in the kitchens of low-income communities in two regions of Kenya; a Maasai community in the Kajiado region south of Nairobi, and an Abaluhya community in Western Kenya.

The technologies used in the project have not been the starting point of the work, but rather, they have come out of discussions with members of those communities into how they feel their needs can best be met. In the Maasai community, windows and smoke hoods have been installed in the project houses, whilst in West Kenya, the community members chose improved stoves, eaves spaces and smoke hoods.

The impact of these technologies has been assessed both in terms of reduction in indoor air pollution, and in the benefits identified by the community members themselves.

A SUMMARY OF WATER PASTEURIZATION TECHNIQUES

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Much of this document is taken from: RECENT ADVANCES IN DEVICES FOR THE HEAT PASTEURIZATION OF DRINKING WATER IN THE DEVELOPING WORLD by Dale Andreatta, Derek T. Yegian, Lloyd Connelly, and Robert H. Metcalf, from the proceedings of the 29th Intersociety Energy Conversion Engineering Conference, American Institute of Aeronautics and Astronautics, Inc., 1994.

Introduction

Water quality and human health have been closely linked throughout history. However, it was not until the last quarter of the 19th century that pioneering work by Robert Koch and Louis Pasteur established the germ theory of infectious disease. With the understanding that fecal-borne bacteria, viruses, and protozoans were responsible for most water-borne diseases, it was possible to develop sanitation and water treatment practices which provided people with a safe water supply. In industrial countries safe water is now taken for granted.

In developing countries however, the burden of disease caused by contaminated water and a lack of sanitation continues to be staggering, particularly among young children. Diarrhea is caused by microbes entering the mouth, most often from contaminated water. According to the United Nations Children's Fund (UNICEF) diarrhea is the most common childhood disease in developing countries. Dehydration resulting from diarrhea is the leading cause of death in children under the age of five, annually killing an estimated five million children. Diarrhea is also the most common cause of child malnutrition, which can lead to death or permanently impaired mental and physical development.[1]

UNICEF estimates that 60% of rural families and 23% of urban families in developing countries are without safe water. In some areas all water supplies may be contaminated.[2] If a water source is suspected of being unsafe, the most common recommendation is to boil the water.[1] This recommendation is seldom followed for several understandable reasons, the most important being the time and the amount of scarce fuel it would require.

Contrary to what many people believe, it is not necessary to boil water to make it safe to drink. Also contrary to what many people believe, it is usually not necessary to distill water to make it safe to drink. Heating water to 65º C (149º F) for 6 minutes, or to a higher temperature for a shorter time, will kill all germs, viruses, and parasites.[3] This process is called pasteurization and its use for milk is well known though milk requires slightly different time temperature combinations.

One obvious problem that arises with pasteurization is the question of how to tell when and if the water has reached the right temperature. Solutions to this problem will be covered in the next section. Pasteurization will not help if water is brackish or chemically contaminated.

In this document we describe several pasteurization techniques applicable to developing countries. Pasteurization is not the only technique that can be used to make water safe to drink. Chlorination, ultra-violet disinfection, and the use of a properly constructed, properly maintained well are other ways of providing clean water that may be more appropriate, particularly if a large amount of water is needed. Conversely, if a relatively small amount of water is needed, pasteurization systems have the advantage of being able to be scaled down with a corresponding decrease in cost. As always, the selection of the right system should be based on local conditions.

This document describes techniques used to pasteurize water, but it is also necessary to educate people about the need for clean water and how to keep their water clean. Among many people in the developing world clean water is not perceived as being important. Also, since many people do not understand how germs are transmitted, many cased have been reported where people unthinkingly recontaminate their clean water by putting it into a contaminated container.

Basic Methods of Solar Water Pasteurization-Solar Cookers

A simple method of pasteurizing water is to simply put blackened containers of water in a solar box cooker, an insulated box made of wood, cardboard, plastic, or woven straw.[3] A solar box cooker is sketched in Fig. 1. One popular type of solar box cooker is made of aluminized cardboard and has a solar collection area of about 58 cm by 48 cm (23 inches by 19 inches). It has a reflective lid that increases the sunlight collected. With this device a yield of 4 to 12 liters (1 to 3 gallons) per day is achieved in the field. Each person requires about 4 liters (1 gallon) of water per day, about half of which is for drinking and the other half is for dish washing and brushing one's teeth. The cost for this device is on the order of $20, US, depending on how easily available the basic materials are.

Figure 1: A solar box cooker being used to pasteurize water.

Other types of solar cookers can be used. A recent development in solar cookers is the solar panel cooker, which consists of reflective panels that concentrate sunlight on the food. The food is in an oven roasting bag to reduce heat loss. Replacing the food with a darkened container of water makes a solar water pasteurizer. While the cost of these panel cookers is low, not more than 2 liters of water can be pasteurized at a time, though in the right climate several batches per day can be pasteurized.

Regardless of the type of solar cooker used, a way of knowing that the water reached the pasteurization temperature is needed. An inexpensive device that does this was developed, and is shown in the Fig. 2. It is a plastic tube with both ends heated, pinched, and sealed, and with a

particular type of soybean fat in one end that melts at 154º F. The tube itself is buoyant, but is weighted with a washer so it sinks to the bottom (coolest) part of the water, with the fat in the high end of the tube. If the fat is found in the low end of the tube at any time after, the water reached the proper temperature, even though the water may have since cooled down. A nylon string makes it easy to take the tube out without recontaminating the water. The tube is reused by flipping it over and sliding the string through the other way. This device works in any size water container, costs about $3, and is available from Solar Cookers International, 1919 21st St., Suite 101, Sacramento, California, 95814, (916) 455-4499, fax: (916) 455-4498. This device also works with fuel-heated water. Since heating the water to the pasteurization temperature rather than the boiling point reduces the energy required by at least 50%, the fuel savings offered by this simple device alone is considerable.

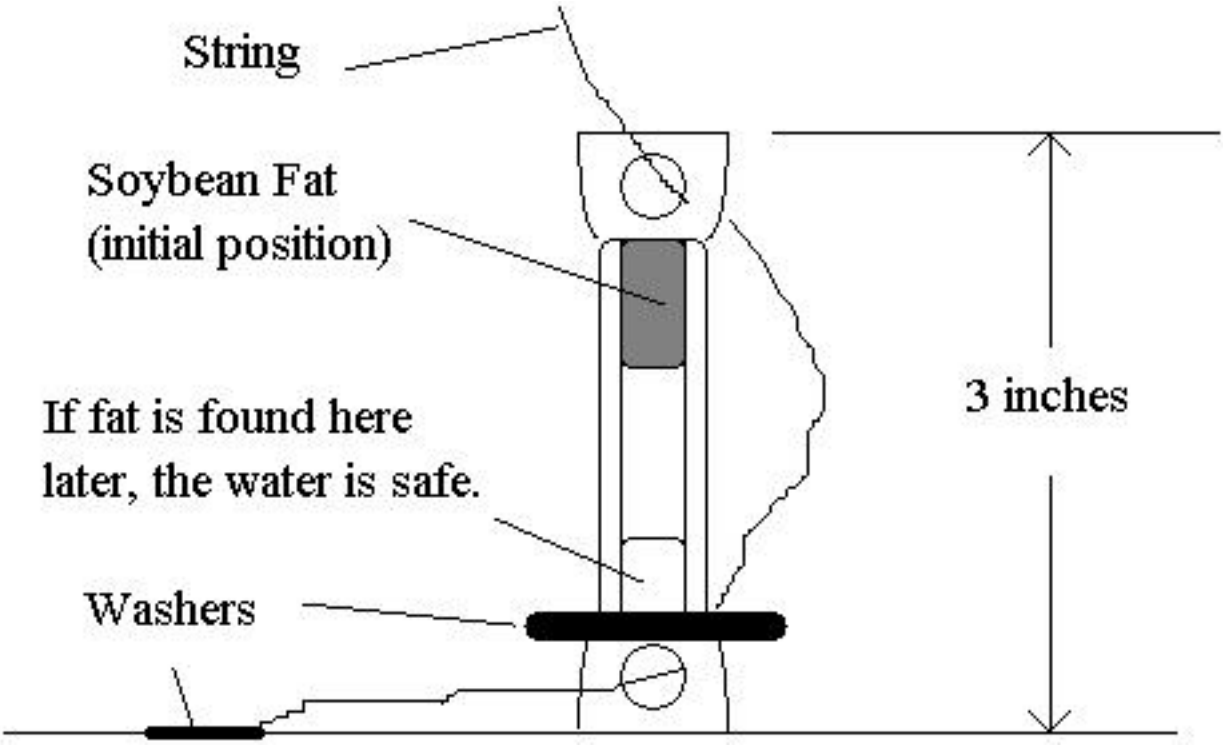

Figure 2: A Water Pasteurization Indicator. The indicator would sit at an angle in the bottom of a water container.

This device works anytime when water is pasteurized in batches regardless of the source of the heat. If one were burning fuel to pasteurize pots of water the pasteurization indicator would still be usable, as long as one didn't get the nylon string too close to the fire. Since heating the water to the pasteurization temperature rather than the boiling point reduces the amount of energy required by at least 50%, the fuel savings offered by this simple device is considerable.

Flow-Through Pasteurization Devices

In order to produce more water PAX World Service produced a flow-through unit which consists of 15 meters (50 feet) of black-painted tubing coiled within a standard solar box cooker. One end of this tubing is connected to a thermostatic valve and the other to a storage tank for the untreated

water supply. This storage tank also contains a sand/gravel/charcoal filter that does the preliminary filtering. The small amount of water (about 1.5 liters) within the tubing allows rapid heating of the water to the valve's opening temperature of 83.5º C (182º F). This is well above the required temperature, but the valve is derived from a mass-produced automotive radiator thermostat valve, so there is a limited selection of opening temperatures. The thermostatic valve opens allowing the pasteurized water to drain out of the tubing and into a second storage vessel for treated water. As the treated water drains from the solar box cooker, contaminated water from the storage tank automatically refills the tubing. Once this cool water reaches the valve the valve shuts and the pasteurization process begins anew.

This flow-through device addresses several of the problems inherent in the batch processes. First, potable water becomes available throughout the day as new increments of treated water are added to the clean storage vessel. Second, this type of unit can adapt to variable solar conditions which takes the guesswork out of filling the jugs in a batch process. If the insolation increases the time required to pasteurize and release the water in the tubing decreases, thus supplying increments of treated water at a faster rate. If insolation decreases the residence time in the solar box cooker will increase, but it will still be pasteurized which may not be the case in a batch unit where the user overestimated the amount of water which could be treated for that day. This is also a totally automatic process, freeing time for other chores and decreasing the likelihood of an accident occurring when transferring water in and out of a batch unit. Field trials by PAX World Service and the Pakistan Council of Appropriate Technology have regularly shown yields of 16 to 24 liters per day (4 to 6 gallons per day). The cost of this device is on the order of $50, US.

Although this is a respectable increase, much more dramatic improvements can still be achieved by recycling the heat in the outgoing pasteurized water. Once the water has been pasteurized and released from the solar box cooker the energy in this water can be used to preheat the incoming water. This process is shown in Fig 3. Since the temperature of the water entering the solar box cooker is higher, it takes less time to finish the pasteurization process, allowing more water to be treated. Also, the flow resistance of the heat exchanger smoothes the flowrate of the water.

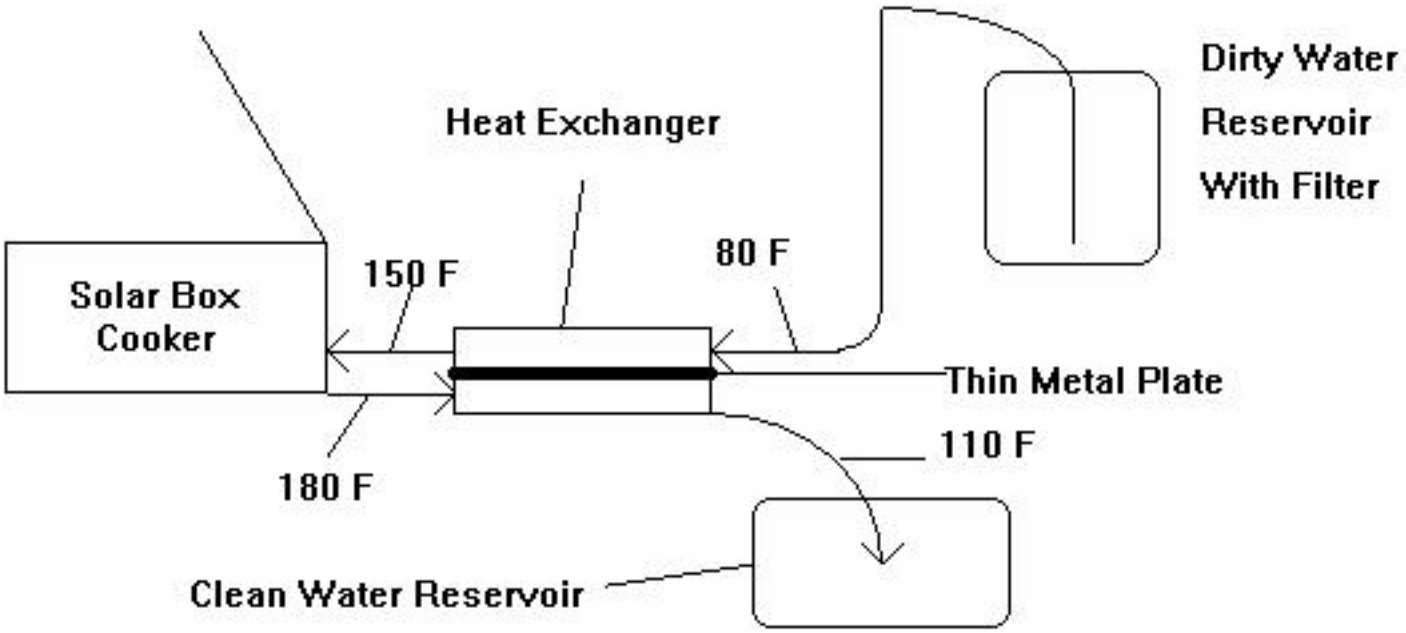

Figure 3: PAX -style water pasteurizer with heat exchanger. Typical temperatures are shown

in degrees Fahrenheit.

A simple device which accomplishes this preheating is a counter-current heat exchanger. The hot water flows on one side of a metal plate, while on the other side of the plate cooler fluid flows in the opposite direction. The energy from the hot water is transferred to the cold water, thus preheating the incoming contaminated water by lowering the temperature of the outgoing pasteurized water.

There are many ways of building a counter-current heat exchanger. Both a tubular version and a flat version have been tested using various configurations and materials, with experimental results favoring the less expensive flat version, though the tubular version is easier to construct from purchased parts. The flat plate unit allows between 75% and 80% of the energy to be reused in preheating the incoming water, and roughly four to five times more water will be pasteurized over a flow-through unit without a heat exchanger. This corresponds to about 80 to 96 liters (20 to 24 gallons) of treated water per day, which is a ten to twelve-fold improvement over the original solar box cooker batch method. An additional benefit is that the chance of burns is greatly reduced because the outflowing water is much cooler reducing the burn hazard. The cost of the heat exchanger itself is on the order of $15 US, making the cost of the complete PAX system about $65. Thus for an increase in cost of about 15% the heat exchanger provides about a 400% increase in water output.

Other Sources of Heat

A heat exchanger can produce benefits with any source of heat, including the exhaust heat from an engine, a fire (that may be used to cook food at the same time,) and heat from other types of solar collectors. We have done some engineering analysis and generated an equation to determine the water output of a particular system of this type. 4 This analysis can also be used to determine the relative benefits of a better heat exchanger, vs. a bigger solar collector vs. a better insulated collector.

If one went with a flame-heated system one would require a short piece of metal tubing, a thermostatic valve with housing, and a heat exchanger. The total cost of this type of system would be about $30. At present we have not done any experiments in this area.

The Solar Puddle-A Low Cost Large Area Device

While many factors determine the usefulness of a water pasteurizer, an important figure of merit is the water delivered per unit cost. A device which is made only of low cost materials is being called a "solar puddle" and it is essentially a puddle in a greenhouse. One form of the solar puddle is sketched in Fig. 4, though many variations are possible.

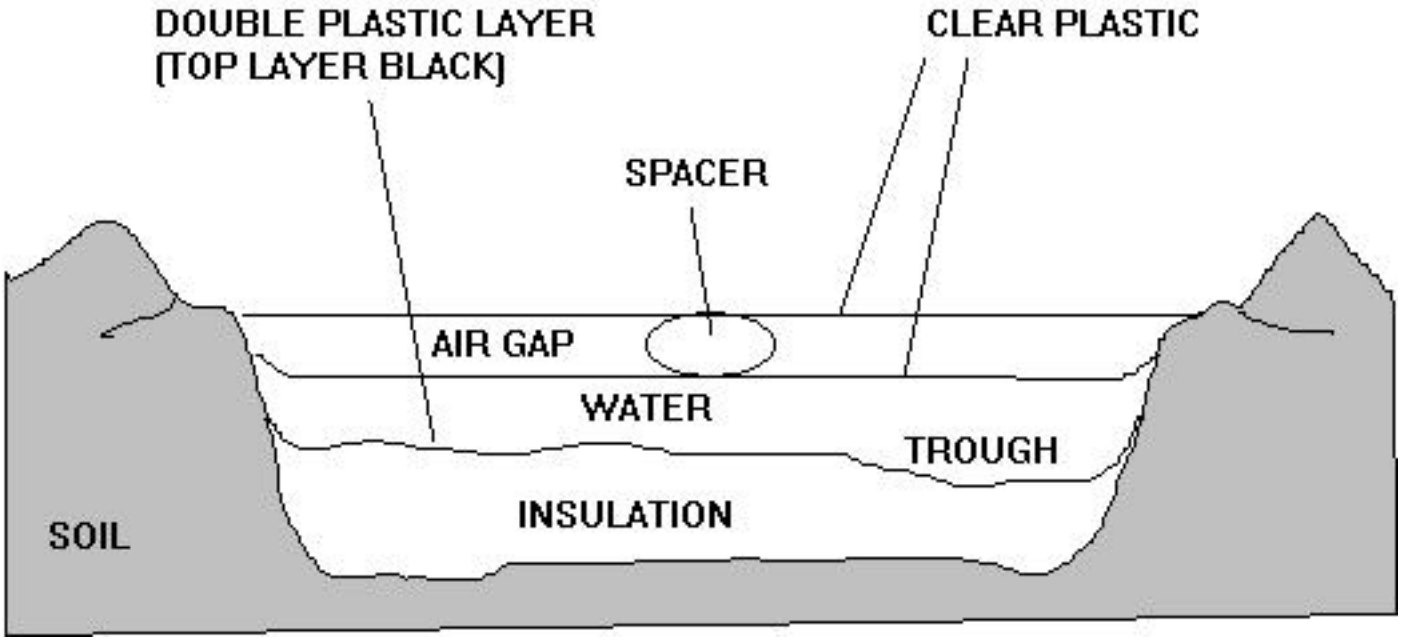

Figure 4: A basic solar puddle. Horizontal dimensions are shown compressed for clarity. A puddle can alse be built with wooden sides on top of a table or roof.

One begins by digging a shallow pit about 10 cm (4 inches deep). The test device was a "family-size" unit, about 1 meter by 1 meter (3 1/2 feet by 3 1/2 feet) but the puddle could be made larger or smaller. If the puddle is made larger there is more water to pasteurize, but there is also proportionately more sunshine collected. The pit is filled with at least 5 cm (2 inches) of solid insulation. We used wadded paper, but straw, grass, leaves, or twigs could be used. This layer of insulation should be made flat, except for a low spot in one corner of the puddle, which is marked "trough" in Fig 4. A layer of clear plastic and then a layer of black plastic goes over the insulation with the edges of the plastic extending up and out of the pit. Two layers are used in case one develops a small leak. We used inexpensive polyethylene from a hardware store, though special UV stabilized plastic would last longer. One would then put in some water and flatten out the insulation so that the water depth is even to within about 1 cm (1/2 inch) throughout the puddle, except in the trough which should be about 3 cm (1 inch) deeper than the rest. More water would be added so that the average depth is 2 to 7 cm (1 to 3 inches) depending on how much sunshine is expected. A pasteurization indicator should go in the trough since this is where the coolest water will collect. At this point the drain siphon should be installed. It should be at the lowest part of the trough so that the most water will be siphoned out before the siphon starts to draw air. The end of the siphon should be held solidly in place by a weight or by several rocks. A layer of clear plastic goes over the water, again with the edges extending beyond the edges of the pit. An insulating air gap is formed by putting one or more spacers on top of the third layer of plastic (large wads of paper will do) and putting down a fourth layer of plastic, which must also be clear. The thickness of the air gap should be 5 cm (2 inches) or more. Finally, dirt or rocks are piled on the edges of the plastic sheets to hold them down. If the bottom of the puddle is flat, well over 90% of the water can be siphoned out.

Once the puddle is built it would be used by adding water each day, either by folding back the top 2 layers of plastic in one corner and adding water by bucket, or by using a fill siphon. The fill siphon should NOT be the same siphon that is used to drain the puddle, as the fill siphon is recontaminated each day, while the drain siphon MUST REMAIN CLEAN. Once in place the

drain siphon should be left in place for the life of the puddle.

The only expensive materials used to make the puddle are a pasteurization indicator ($2-$3), a siphon tube (about $1), and 4 sheets of plastic (about $2 for the size tested). Many tests were done in the spring and summer of 1994 in Berkeley, California. On days with good sunshine the required temperature was achieved even with 68 liters (17 gallons) of water corresponding to a depth of 62 mm (2 1/2 inches). With thinner water layers higher temperatures can be reached. With 24 liters (6 gallons) corresponding to a depth of 21 mm (1 inch) 80º C (176º F) was achieved on one day.

The solar puddle works even under conditions that are not ideal. Condensation in the top layer of plastic doesn't seem to be a problem, though if one gets a lot of condensation the top layer should be pulled back to let the condensation evaporate. Small holes in the top layers don't make much difference. The device works in wind, or if the bottom insulation is damp. The water temperature is uniform throughout the puddle to within 1º C (2º F).

After some months the top plastic layers weaken under the combined effects of sun and heat and have to be replaced, but this can be minimized by avoiding hot spots such as places that are exposed to the sun but not cooled by the water. Another option would be to use a grade of plastic that is more resistant to sunlight. The two bottom layers of plastic tend to form tiny tears unless one of very careful in handling them. This is why there are two layers on the bottom. A tiny hole may let a little water through and dampen the solid insulation, but this is not a big problem.

There are many variations of the solar puddle. The least expensive form of a solar puddle is built into the ground as in Fig. 4, but a puddle could be built with wooden sides on top of the ground, on a tabletop, or on a roof. We've been able to put the top layer of plastic into a tent-like arrangement that sheds rain. This would be good in a place that gets frequent brief showers. Adding a second insulating layer of air makes the device work even better, though this adds the cost of an extra layer of plastic. As mentioned the device can cover a larger or smaller area if more or less water is desired. A larger puddle would have a higher initial cost, but a lower unit cost for the water, since the same drain line and water pasteurization indicator could be used. One could make a water heater by roughly tripling the amount of water so that the maximum temperature was only 50º C (120º F) or so, and this water would stay warm well into the evening hours. This water wouldn't be pasteurized though. One could help solve the problem of dirty water vessels by putting drinking cups into the solar puddle and pasteurizing them along with the water. The solar puddle could possibly cook foods like rice on an emergency basis, perhaps in a refugee camp.

Cost Summary

The table below shows an approximate cost summary of the basic methods of water pasteurization described in this document. The initial cost is the amount of money that needs to be spent to get the system running. The water produced per dollar of long term cost is based on a 5-year lifetime, and includes expected maintenance costs and replacement parts. In some cases, a), b), and c) in particular, the maintenance costs are small. For the solar puddle, cases e) and f), the replacement costs for the plastic layers that degrade in the sunlight make up the majority of the long-term cost.

The assumption used in these calculations are:

1. The fuel cost is $0.02 per liter of boiled water (cases a) and b)). This number comes from a recent issue of the Solar Cookers International newsletter, and is the amount of money that some people in the developing world are willing to pay for the fuel to boil drinking water.
2. Pasteurization indicators must be replaced twice in 5 years (cases b), c), e) and f)).
3. Thermostatic valves must be replaced once in 5 years (case d)).
4. For the solar puddle the top 2 layers of plastic are replaced every 3 months, while the bottom 2 layers are replaced every 6 months (cases e) and f)).

System Name	Initial Cost (US dollars)	Liters of Water per Dollar (long term)
a) Flame-heated water pot (heated to boiling with no pasteurization indicator)	small	50
b) Flame-heated water pot with pasteurization indicator	3	96
c) Solar Box Cooker with pasteurization indicator	23	375
d) PAX unit with recuperator	65	580
e) Solar Puddle ("family size")	6	1800
f) Solar Puddle (community size, 10 ft. by 25 ft.)	25	3500

It can be seen that the systems using fuel have low initial cost but high long term cost. The pasteurization indicator is an inexpensive way of nearly doubling the water produced per unit of fuel, though the long term costs of such systems are still high due to the cost of the fuel. The solar puddle has low initial cost and low long term costs, but involves the work of replacing the plastic layers frequently.

Conclusion

In this document water pasteurization has been presented as a way of providing clean drinking water in developing countries. Several techniques for pasteurizing water have been presented here. Some of these methods are less expensive, some produce more water per day, and some are in the form of a compact device that is easy to ship and set up in the field. Pasteurization is only one way of providing clean water. The purpose of this document is not to say that pasteurization is the best way of providing drinking water or to say that one pasteurization technique is necessarily better than other. As always, the selection of a method for providing clean water should be based on local conditions, and the selection process should include a variety of social factors as well as the technical and cost factors explored here. Field experience shows that education is also necessary to achieve successful results with any water system.

References:

1. UNICEF, The State of the World's Children, 1988, Oxford University Press, pg. 3, 1988.

2. UNICEF, The State of the World's Children, 1989, Oxford University Press, pg. 48, 1989.

3. Ciochetti, D. A., and Metcalf, R. H., Pasteurization of Naturally Contaminated Water with Solar Energy, Applied and Environmental Microbiology, 47:223-228, 1984.

4. Recent Advances in Devices for the Heat Pasteurization of Drinking Water in the Developing World, Dale Andreatta, P. E., Derek T. Yegian, Lloyd Connelly, and Robert H. Metcalf, Proceedings of the 29th Intersociety Energy Conversion Engineering Conference, 1994.

See also Solar Water Pasteurizers Make Safe Drinking Water in Tanzania

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Community development

The Questions

Eight questions that will tell if a community will truly benefit from a development project:

1. What are the most pressing needs of this community?
2. Is the proposed project addressing these needs?
3. Is there participation by the community in the process of:
   - Identifying key problems?
   - Planning realistic solutions?
   - Carrying out the plans?
   - Measuring the success of the project?
4. Is the project financially and logistically feasible?
5. Will the community permanently benefit from the project?
6. Will the beneficiaries achieve empowerment in terms of:
   - Economic independence?
   - Control of resources and decisions?
   - Self-confidence that they can make a difference?
7. Will the project have a positive impact on the environment?
8. Will the project have a positive impact on the role and participation of women?

The causes of poverty

Each day 34,000 children die from malnutrition and disease.

In the world's poorest countries, only 34% of people have access to safe drinking water. 1 in 5 people in developing countries (about 780 million people) lacks enough food to meet basic daily needs.

Poverty is more than the absence of material means or basic services, such as a lack of food, shelter, clean water, education or health. Poverty creates powerlessness to determine the quality of life, and compounds vulnerability when conflict or natural disaster strikes.

Although the proportion of people living below the poverty line has fallen since the mid-1980s, the absolute number of poor people has risen to 1.3 billion -- 8 per cent more than in the mid-1980s.

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HOMeR
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Education resources on the Web
Children's poetry

We believe that most suffering is avoidable, being caused either by the direct action of others or indirectly through injustice, selfishness, inequality, neglect, or environmental and socio-economic imbalance.

The International Economic System

It is estimated that developing countries are being denied US$500 billion of market opportunities every year, as compared with the US$50 billion they receive in aid. Much of that aid is poorly targeted and does little to meet the priority needs.

Debt repayments continue to impose a huge burden on the poorest countries. In 1989, developing nations paid US$52 billion more to the developed world in interest payments on debt, than they received in aid and new loans.

The economic reform programs devised by the International Monetary Fund and the World Bank are contributing in many countries to the worsening plight of the poor through rising unemployment, higher prices and cuts in vital social services.

Severe as these factors are for the whole Third World, their effects are particularly crippling in Africa.

Poverty & The Environment

Inequitable land holding, corrupt and inadequate governments and increasing conflict all add to the burden of the poorest.

Environmental degradation, undermining the livelihoods of poor women and men, is both a cause and an effect of poverty.

According to the United Nations Development Programme, more than 850 million people live in areas in various stages of desertification. Growing environmental degradation places particularly acute stress on women as providers of fuel, wood and water for family needs.

Poverty and Women

Although women form over half the world's population, they receive only a small share of development opportunities.

Two thirds of the world's illiterate population are women.

Twice as many men as women are in paid work and if women's unpaid work as carers for the family and the household was counted as productive output in national income accounts, it is

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estimated that global output would increase by 20-30 per cent.

-- Adapted from Oxfam Hong Kong
http://www.oxfam.org.hk

The myth of scarcity

"There just isn't enough food for everyone." **Nonsense!** While it's true -- all too true! -- that 840 million people go hungry, it's not because there isn't enough food. In fact there's more than enough -- there's more food than there's ever been before. Which makes the dreadful fact of the world's hungry even more appalling. How can this be so?

The Institute for Food and Development Policy ("Food First") has the best explanation -- and they've got all their facts right.

12 Myths About Hunger

"**Myth 1** -- Not Enough Food to Go Around. **Reality** -- Abundance, not scarcity, best describes the world's food supply. Enough wheat, rice and other grains are produced to provide every human being with 3,500 calories a day. That doesn't even count many other commonly eaten foods -- vegetables, beans, nuts, root crops, fruits, grass-fed meats, and fish. Enough food is available to provide at least 4.3 pounds of food per person a day worldwide: two and half pounds of grain, beans and nuts, about a pound of fruits and vegetables, and nearly another pound of meat, milk and eggs -- enough to make most people fat!"
So why do so many go hungry? "12 Myths About Hunger" and "The Myth of Scarcity" are essential reading -- based on "World Hunger: 12 Myths", 2nd Edition, by Frances Moore Lappé, Joseph Collins and Peter Rosset, with Luis Esparza (fully revised and updated, Grove/Atlantic and Food First Books, Oct. 1998).
12 Myths About Hunger
http://www.foodfirst.org/pubs/backgrdrs/1998/s98v5n3.html
The Myth of Scarcity
http://www.foodfirst.org/pubs/backgrdrs/1998/w98v5n1.html

"World Hunger: Twelve Myths", 2nd ed., by Frances Moore Lappe, Joseph Collins, Peter Rosset with Luis Esparza, Food First/The Institute for Food and Development Policy, 1998, 270pp, $13.00.
First published in the early 1970s, the World Hunger report is an authoritative resource on the problem of global hunger -- highly recommended. It debunks 12 persistent misconceptions about

hunger. Thorough examination of the issue. The book isn't just a damnation of wrong-headed development efforts, it also offers a well-considered way forward.
http://www.foodfirst.org/media/press/1999/wohucop.html

"Going Hungry is a Violation of Human Rights says UN Agency Head" -- Jacques Diouf, Director-General of the United Nations Food and Agriculture Organisation (FAO), has warned that under-nourishment and starvation should not be considered less serious than blatant violations of other human rights. "The state has the obligation, as an instance of last resort, to ensure that nobody should die of hunger," he said. -- Europaworld September 21, 2001
http://www.europaworld.org/issue49/goinghungry21901.htm

"And So The Babies Die", by Trudy Thomas, Analysis, Mail & Guardian (Johannesburg), September 26, 2001: "We may well find that if we look after the health of the babies, the whole economy, and not only its growth component, will begin to grow healthier too."
http://allafrica.com/stories/200109260010.html

"Progress in reducing hunger has virtually halted", Rome, 15 October 2002 -- Progress in reducing world hunger has virtually come to a halt, the UN Food and Agriculture Organization (FAO) said in its annual report "The State of Food Insecurity in the World 2002". As a result of hunger, millions of people, including 6 million children under the age of five, die each year.

"We do not have the excuse that we cannot grow enough food or that we do not know enough about how to eliminate hunger. What remains to be proven is that we care enough, that our expressions of concern in international fora are more than rhetoric, that we will no longer accept and ignore the suffering of 840 million hungry people or the daily death toll of 25 000 victims of hunger and poverty," said FAO Director-General Dr. Jacques Diouf.

Most of the widespread hunger in a world of plenty results from poverty, the report said.
http://www.fao.org/english/newsroom/news/2002/9620-en.html

The State of Food Insecurity in the World 2002
http://www.fao.org/docrep/005/y7352e/y7352e00.htm

Facts About World Hunger

• The world produces enough food to feed everyone. World agriculture produces 17 percent more calories per person today than it did 30 years ago, despite a 70 percent population increase. This is enough to provide everyone in the world with at least 2,720 kilocalories (kcal) per person per day). The principal problem is that many people in the world do not have sufficient land to grow, or income to purchase, enough food.
Source: Food and Agriculture Organization 2002, FAO 1998

• There are 1.2 billion poor people in developing countries who live on $1 a day or less. Of these, 780 million suffer from chronic hunger, which means that their daily intake of calories is insufficient for them to lead active and healthy lives.
Source: Food and Agriculture Organization 2002, FAO 1998

• Protein-energy malnutrition (PEM) affects every fourth child worldwide: 150 million (26.7%) are underweight while 182 million (32.5%) are stunted. Geographically, more than 70% of PEM children live in Asia, 26% in Africa and 4% in Latin America and the Caribbean. Their plight may well have begun even before birth with a malnourished mother.
Source: World Health Organization 2002
http://www.stophungernow.org/hunger_facts.html

See **Community development** -- Change not Charity, Rural Reconstruction, Credo

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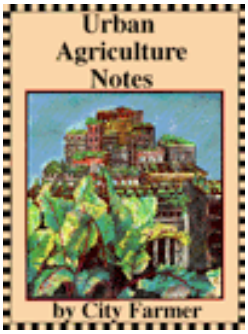

City Farmer's Urban Agriculture Notes, by City Farmer, Canada's Office of Urban Agriculture -- large and excellent site, at the centre of the burgeoning urban farming movement -- thorough coverage of all aspects of this fascinating and hopeful subject, from green roofs in Berlin and Chicago, through school gardens, organics, compost, vermiculture, composting toilets, and edible parks to the millions of destitute people fighting hunger and pollution in Third World shantytowns, and much more.
http://www.cityfarmer.org/
Site search engine (you'll need it!):
http://www.cityfarmer.org/htdig/search.html

The **Cities Feeding People (CFP)** Program Initiative, International Development Research Centre (IDRC), Ottawa, Canada, supports development research to remove constraints and enhance the potential for urban agriculture to improve household food security, income generation, public health, and waste and land management. Large site, loads of useful information and resources here.
http://www.idrc.ca/cfp/
Search IDRC's collection of more than 10,000 multimedia documents.
http://search.idrc.ca/

"Cities Feeding People: An Examination of Urban Agriculture in East Africa" by A. Egziabher, D. Lee-Smith, D. Maxwell, P.A. Memon, L.J.A. Mouget, C.J. Sawio, 1994, IDRC, ISBN 0-88936-706-X, CA $25 ($15.00 in developing countries)
Food prices have soared in the South, and the urban poor can't afford it. By the late 1980s, cities of the developing world had to import half their food supply. It's argued that urban agriculture can reduce this dependency -- but most Southern governments do not support it. This book examines urban agriculture in East Africa and proves that it a safe, clean, and secure method to feed the world's struggling urban residents. It documents the extensive role urban agriculture already plays in East Africa, with detailed case studies from Tanzania, Uganda, Kenya, and Ethiopia. Solid facts to convince governments that urban agriculture should play a larger role in feeding the urban population.
Order online from IDRC:
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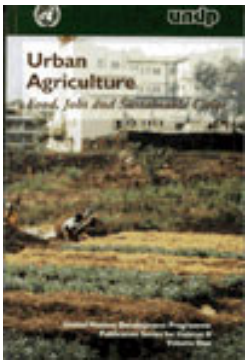

"Urban Agriculture: Food, Jobs and Sustainable Cities" by Jac Smit, Annu Ratta and Joe Nasr, UNDP, Habitat II Series, 1996, ISBN 9211260477
The experience of urban farming in countries across Asia, Africa and Latin America in one book, based on exploratory trips to more than 20 countries and extensive research over many years. Is urban farming a marginal activity practised for survival by the poor, just a relic of rural habits, or is it a modern economic activity with major significance for food security, stable family incomes and a livable urban environment? The book examines urban food production systems (including animals) worldwide. Well-researched, with many case studies and pictures, helpful perspectives on the current status and potential of food and income production in the city. Who the farmers are, where they farm, what the crops are, the benefits and constraints, the legislative, urban management and market environment, the history and current status of urban farming. The book fills an information gap about city farming and presents a convincing case for urban food production. Commissioned by the Urban Agriculture Initiative of the UNDP. From the Urban Agriculture Network, 1711 Lamont Street NW, Washington DC 20010, USA -- US$24.00 check or money order (includes subsidy for countries that have difficulty raising US$):
email 72144.3446@compuserve.com
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http://www.cityfarmer.org/smitbook90.html#smit
Scientific American: Analysis, June 1996 -- Urbaculture: "Cities of the developing world learn to feed themselves":
http://www.sciam.com/0696issue/0696scicit02.html

"The Urban Agriculture Network: 1999 Activity Report" -- The Urban Agriculture Network (TUAN) was formed in 1993, and now has 3,000 members in 40 (primarily developing) countries. Information and technical referral service, networking among groups, sponsorship for regional workshops and newsletters, advice on Urban Agriculture policy, and support for research. Contact Jac Smit (President) at 1711 Lamont St., N.W., Washington, D.C. 20010, USA; phone 202/483-8130; fax 202/986-6732; email 72144.3446@compuserve.com.
http://www.cityfarmer.org/TUAN.html

"What Would the World be Like in the 21st Century if Cities Were Nutritionally Self-Reliant? -- The prospect for Urban Agriculture" by Jac Smit, President, Urban Agriculture Network, co-author of "Urban Agriculture: Food, Jobs, and Sustainable Cities".

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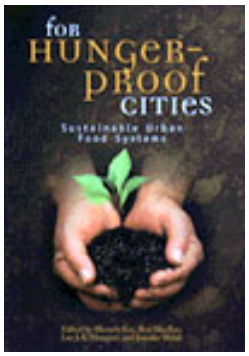
Container Farming -- Organic food production in the slums of Mexico City. Fifteen million Mexicans live in extreme poverty -- above all in marginal urban areas like the slums of Mexico City. Seven years ago a group of NGOs launched a project to help people there to grow their own food organically in small backyards or patios, balconies, rooftops -- as a way to help counteract the poverty being imposed upon them. This is the report on the project, by sociologist and community worker Rodrigo A. Medellín Erdmann.

Urban Agriculture in Mexico City -- "Our research has reported that producers keep an average of 3 pigs and 26 birds per household, but there are some individuals who manage up to 60 pigs, all kept within the family... Their nutrition is based on the use of food wastes available from the city including kitchen wastes, stale bread and tortilla, left-over tortilla dough, chicken guts, and fruit and vegetable wastes from the markets, amounting to 4,000 tonnes per day." By City Farmer.
http://www.cityfarmer.org/mexico.html#mexico

Resource Centre on Urban Agriculture and Forestry (RUAF), based in the Netherlands, international perspective, particularly on Third World issues. Urban Agriculture Magazine, in English, Spanish and French, published three times a year, full text at the website; good library of online documents and resources, bibliographic urban agriculture database, search online or download, nerws, links and more.
http://www.ruaf.org/



"For Hunger-proof Cities: Sustainable Urban Food Systems" edited by Mustafa Koc, Rod MacRae, Luc J.A. Mougeot, and Jennifer Welsh, 1999, IDRC, ISBN 0-88936-882-1
With massive growth in urban populations and hunger and malnutrition on the increase worldwide, this is the first full examination of food security from an urban perspective. It examines existing local food systems and ways to improve food access and availability for city dwellers. It looks at ways to improve community-supported agriculture and cooperation between urban and rural populations, the emerging forms of food-distribution systems and how they can contribute to alleviating hunger in the cities, and the underlying structures that create poverty and inequality. It includes contributions from farmers and professors, young activists and experienced business leaders, students and policymakers, community organizers and practitioners. Order online from IDRC:
http://www.idrc.ca/books/882.html

Urban Agriculture -- Gardening, Market Gardening, Mini-farming and Mini-ranching, by Ken Hargesheimer: "Bouake, Cote d'Ivoire, is an example of urban agriculture. Every vacant piece of

land is planted. Even the land between the street and the property line is growing corn and/or yams. Vacant lots and land are everywhere in this country [the US]. Many factories, plants, churches, schools, colleges, city and county goverments have unused land. Use it for food production, recycle waste, green areas and beautification of the city. Use organic, biointensive raised beds. Yields are 2-5 times the national average... City governments must recognize the potential of urban agriculture and accord it the status given to other industries and economic activities in the city."
http://www.homestead.org/urbanag.htm

"Growing Food in Cities" by Tara Garnett, 1996, National Food Alliance/SAFE Alliance, ISBN 1-889779-35-3
Thorough overview of urban food growing and why it's important for sustainable development. Agenda 21, community development, health-promotion, environment, marketing, leisure services, education, and more.
Order online from Sustain:
http://www.sustainweb.org/pub_growing.shtm

"**Urban Agriculture in Drylands**" -- Arid Lands Newsletter No. 42, Fall/Winter 1997. Katherine Waser of the Arid Lands Information Center at the University of Arizona has put together a fascinating issue of the Arid Lands Newsletter. Included is a report on urban agriculture in Middle Eastern cities by Joe Nasr and Paul Kaldjian and another featuring city farming in Istanbul, also by Paul Kaldjian.

Urban farming outside the ancient walls of Istanbul (Arid Lands Newsletter No. 42)

http://ag.arizona.edu/OALS/ALN/aln42/aln42toc.html

"Urban trees in arid landscapes: Multipurpose urban forestry for local needs in developing countries" by Guido Kuchelmeister, in Arid Lands Newsletter No. 42, Fall/Winter 1997, Urban Agriculture in Drylands -- Trees can contribute significantly to the food requirements of the urban poor, both on a daily basis and in times of crisis. Urban forests improve the quality of urban life in many ways. Tangible benefits include fuelwood, food, fodder, and building materials. Environmental and social benefits relate to public health, recreation, and well-being of the urban population, including reduction of air and noise pollution, climate improvement, and landscape enhancement. Green areas also provide habitats for wildlife, erosion control, protection of watersheds for urban water supply and productive uses or safe disposal of urban wastes.
http://ag.arizona.edu/OALS/ALN/aln42/kuchelmeister.html

"Farming in the City: The Rise of Urban Agriculture", IDRC Reports, October 1993 (Volume 21, Number 3) -- Millions of people in the growing cities of the South have become urban farmers in recent decades. They grow vegetables, raise livestock, poultry and fish, and

practise many other types of agriculture. They enjoy better diets, higher income, employment or combinations of all these benefits. Urban farming also brings major benefits to the urban environment, putting marginal lands to good use, absorbing wastes in the form of compost and fertilizer, and has a positive impact in water issues and energy management. It is a new vision of the city, seen as part of the natural resource base and as a producer of agricultural goods rather than only as a consumer. Overview -- Urban Food Self-Reliance, New Challenges for China's Urban Farmers, A Plot of One's Own in West African Cities, Farming Logic in Kampala, Recognizing Ethiopia's Urban Farmers, Breaking New Ground in Dar es Salaam, The Neglected Industry of Kenyan Cities, Chasing Away Hunger in Bolivia, and more.
http://www.idrc.ca/books/reports/V213/index.html

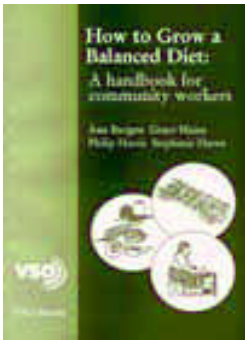
"Time to help the city farmers of Africa" by Diana Lee Smith (1996), from "Greening the Cities", People and the Planet 5(2) (special Habitat II issue) -- the story of Wairumu Kinuthia, a grandmother and urban farmer in Nairobi, Kenya. It gives a "human face" to the contention that women farmers are crucial to urban agriculture, and urban agriculture is often crucial to women's survival, as well.
http://carryon.oneworld.org/patp/vol6/leesmith.html

"Vegetable Gardens in the City, Zimbabwe" -- Adrienne Martin and Nicolienne Oudwater from the NRI have investigated how poor urban farmers -- who are mostly women -- can help to feed their families and earn cash on urban plots in three areas around Harare. They have found that in some parts of the city more than two-thirds of households carry out some farming, either around their homes or on public land such as roadside verges. Aerial surveys suggest that the area of the city under cultivation has doubled in the past decade. (From "In the Field", BBC World Service and the Natural Resources Institute of the University of Greenwich.)
http://www.nri.org/InTheField/harare_peri_urban.htm

"Above-Ground Gardens" by Dr. Martin L. Price & Laura S. Meitzner, 1996, ECHO Technical Note (reprinted from Ch 17 of ECHO's book Amaranth to Zai Holes, 1996), Educational Concerns for Hunger Organization (ECHO)

Urban food production is often overlooked by development planners. There is considerable potential to involve millions of city families in food production, who may not at first seem to have anywhere to garden -- where there is plenty of sunshine but either no soil or the soil does not lend itself to cultivation. ECHO and others have developed "above-ground" techniques suited for such sites: the countless hectares of sturdy, flat cement rooftops and many more hectares of tin roofs on insubstantial shanties, steep hillsides, extremely poor soils, yards of rock

or cement, spaces around tree roots, and places where land tenure is so unstable that only portable gardens are attractive. ECHO has been working on methods for gardening in such situations since 1982. Online (Acrobat file):
http://www.echonet.org/tropicalag/technotes/Abovegro.pdf
Full-length version, in Amaranth to Zai Holes:
http://www.echonet.org/tropicalag/aztext/azch17.htm



"How to Grow a Balanced Diet" by A. Burgess, G. Maina, P. Harris, and S. Harris, 1998
Undernutrition is a widespread curse. This book provides practical information on how to identify nutritional problems and how to grow nutritious crops and vegetables to improve a community's diet. It explains the basic techniques of organic growing in non-technical language for those without agricultural training or background. The book lists more than 40 common food crops and vegetables from a wide range of agro-climatic zones, with step-by-step instructions on how to grow and store them. Designed for small vegetable gardens or farms. From ECHO's global bookstore
http://echonet.org/shopsite_sc/store/html/HowGrowBalancedDiet.html

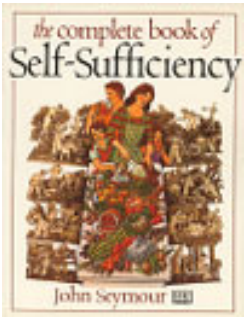
"Backyard Market Gardening: The Entrepreneur's Guide to Selling What You Grow" by Andrew W. Lee, Good Earth, 1995, 0-964648-0-5
Market gardening with vegetables, fruits, flowers, herbs and small livestock in your backyard. Good marketing advice, compares different market strategies, good guide for newcomers to organic gardening, and a good read too. Not just a dull how-to book. From Rodale Institute Bookstore:
http://rodaleinstitute.org/bookstore/products/farm_books/2.html

"Small Scale Aquaculture: A Guide to Backyard Fish Farming" by Steven D. Van Gorder, 1992, Rodale Institute, ISBN 0-9677732-0-2
Details and plans on how to raise, harvest, prepare, and store over 100lbs of fish in five months. This system is the result of eight years of research at the Rodale Research Center. A simple and efficient way to produce your own fish on a scale appropriate for a self-sustaining household. Makes home aquaculture as practical as gardening for providing healthy food for a family. Features an ecologically sound recirculating system designed for low energy and low water use made from readily available materials. From Rodale Institute Bookstore:
http://rodaleinstitute.org/bookstore/products/farm_books/3.html

Roofwater Fish Farm Ideal For Learning -- Australian Vivienne Hallman is proving that urban fringe farmers can grow native fish successfully on natural foods. Most of the water can come from a home rooftop. Much of the fish food can be home-grown earthworms and insect larvae. Vivienne's project has shown how Australian native fish could be

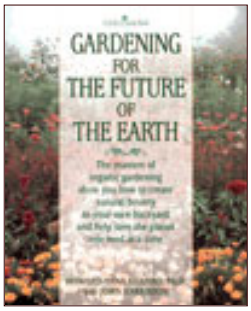
reared in a small area on worm-farmed kitchen scraps -- to give benefits to a vegetable or fruit tree garden. "One crop a year of silver perch is possible with unheated water," she said. Up to 50 fish a year can be raised in a 4,000-litre [900 gallons], unheated tank, to 350 to 400 gram size [about 1-lb]. "This means each of my five tanks is capable of raising 17 to 20 kg [37-44 lb] of silver perch under the non-stressful growing conditions I favour," Vivienne said.
http://www.cityfarmer.org/fishfarm.html

See **Aquaculture for small farms: Aquaculture resources**



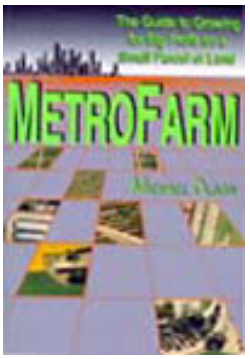
"The Complete Book of Self Sufficiency" by John Seymour, 1976, 1997, Dorling Kindersley, ISBN 0751304263
Seymour has been described as the 'guru' of self sufficiency and says it all in this book. From planning a 1 or 5 acre plot to crop rotation, from making bread to building a furnace. Essential accessory to self-sufficiency, whether you need to remove a tree stump, butcher livestock, harness a ploughhorse, plan a dairy or dress stone. Features many forgotten crafts that have been lost to convenience food and supermarkets. Comprehensive. Great drawings and all the information you need. From Amazon.co.uk:
http://www.amazon.co.uk/exec/obidos/ASIN/0751304263/qid=979231196/202-7185636-5219825

"City Harvest: The feasibility of growing more food in London" -- by Tara Garnett, 1999, Sustain, ISBN 1-9030-60-01-x
"Using a productivity level of 10.7 tonnes/ha drawn from research into allotment yields, London could produce around 232,000 tonnes of fruit and vegetables. Taking the World Health Organization's recommendation that we should eat around 0.5kg of fruit and vegetables a day (five portions), the amount potentially available would supply Londoners with 18% of their daily intake -- roughly one of the recommended five portions a day." Londoners eat 2,400,000 tonnes of food each year and produce 883,000 tonnes of organic waste. Home to only 12% of Britain's population, London nevertheless requires the equivalent of the entire productive land area of Britain to sustain itself. Order online from Sustain:
http://www.sustainweb.org/pub_growing.shtm
Detailed review at City Farmer:
http://www.cityfarmer.org/uk.html#uk



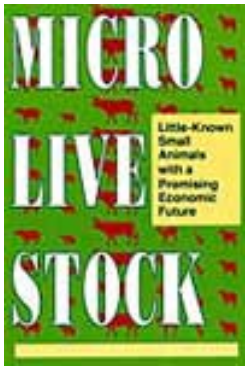
"Gardening For The Future Of The Earth" by Howard-Yana Shapiro, Ph.D., Agricultural Director, Seeds of Change, and John Harrisson, with Permaculture founder Bill Mollison, Biointensive master gardener John Jeavons, Alan York, Alan Kapuler, Carol Deppe, Wes Jackson and Masanobu Fukuoka ("The One Straw Revolution") -- an all-star caste! Published by Seeds of Change, 2000, softcover,

240 pages, discounted Website price $18.95.
http://store.yahoo.com/seedsofchange/garforfut.html

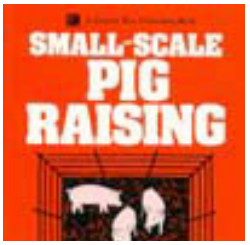


"MetroFarm: The Guide to Growing a Big Profit on a Small Parcel of Land" by Michael Olson, 1994, ISBN 0-963787-60-8
According to a recent US Census of Agriculture, the most productive farmland in the United States is in the Borough of the Bronx, the second most productive farmland is in the City of San Francisco. How to earn up to eight times the average personal income on as little as one acre of land. Written for both the experienced and the novice, MetroFarm presents the modern and centuries-old technologies used by space-intensive farmers from around the world. Photos, charts and illustrations. From ECHO's Global Bookstore
http://echonet.org/shopsite_sc/store/html/MetroFarm.html
From MetroFarm Online:
http://www.metrofarm.com/book.htm

The Smallholding Plan from Britain's Country Smallholding magazine provides a blueprint for anyone about to buy a smallholding or who wishes to make productive use of a little land -- anything from a large garden and small orchard to several acres. Sage advice here -- David and Katie Thear are veterans at the smallholding game. Subjects covered: buying a country property, the kitchen garden, chickens, ducks, geese, turkeys, quail, rabbits, sheep, goats, house cow, pigs, bees. Each with Key factors, Space, Time, Energy and Money, and Further information. Useful.
http://www3.mistral.co.uk/cgs/smallhol.htm

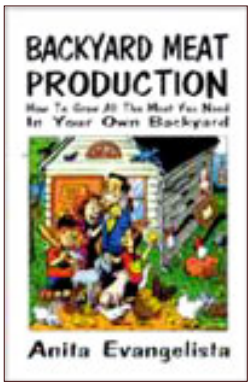


"Microlivestock: Little-Known Small Animals with a Promising Economic Future", 1991, Board on Science and Technology
Small animals require less feed and space and are easier to care for. This fascinating report makes suggestions for replacements for conventional livestock. Covers the microbreeds of cattle, goats, sheep, pigs, many breeds of poultry, rodents, deer, rabbits, lizards, and others, with appearance, distribution, habitat, biology, behavior, care, pros and cons, and research needs. Read it online (free) or print it out at the National Academy Press:
http://www.nap.edu/books/030904295X/html/

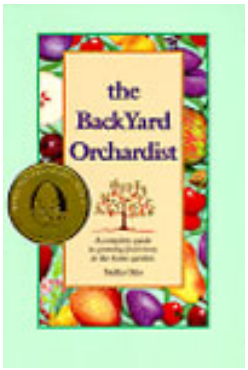


"Small-Scale Pig Raising" by Dirk van Loon, 1978
Explains exactly why raising a feeder pig is the best bet for someone with little land who wants to produce the most meat for the smallest investment of time and money. Covers everything from buying a pig to smoking your own bacon. "In writing this book I have

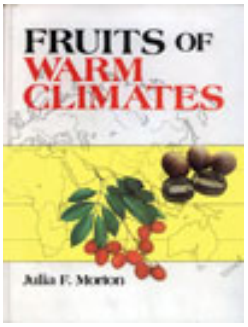
tried to create the kind of how-to and why guide I wish I'd had when we first raised pigs." For beginners, but goes further and deeper than most introductory books. History, swine management practises through the centuries, home butchering, with step-by-step instructions and many photos covering the entire process from slaughtering to portioning meat for the freezer. From ECHO's Global Bookstore: http://echonet.org/shopsite_sc/store/html/SmallScalePigRaising.html



"Backyard Meat Production: How to Grow All the Meat You Need in Your Own Backyard" by Anita Evangelista, 1997, Breakout Productions, ISBN 1559501685
You needn't live in the country -- most urban areas allow for small-animal husbandry at home. Instructions help you meet the family's animal-protein needs for a fraction of your current costs, and do-it-yourself feeding and butchering means healthier meat -- no food additives, no sloppy processing, no lethal diseases. Covers rabbits, chickens, quail, pheasants, guinea fowl, ducks, mini pigs, mini goats, plus leather, feathers, bones, and fibre, butchering, with a resources list. Practical.

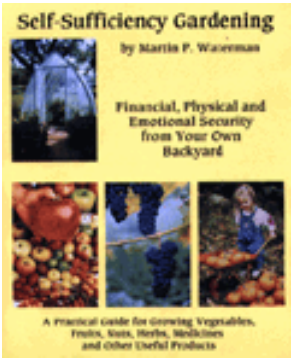


"The Backyard Orchardist: A Complete Guide to Growing Fruit Trees in the Home Garden" by Stella Otto, revised edition 1995, Otto Graphics, ISBN 0963452037
Step-by-step guidance from a true expert on how to start your orchard -- planning, soil, tree selection for your climate, planting, pruning, pest management, harvesting and storing, everything you need to know.
From Powell's Books:
http://www.powells.com/biblio/126200-126400/0963452037.html
From Chelsea Green:
http://www.chelseagreen.com/DP/Otto/BYOrchardist.htm

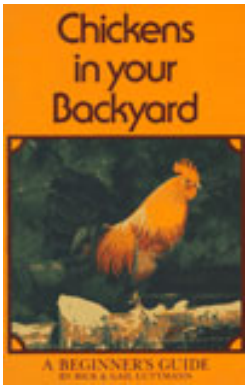


"Fruits of Warm Climates" by Julia F. Morton, ISBN: 0-9610184-1-0
Julia F. Morton is Research Professor of Biology and Director of the Morton Collectanea, University of Miami, a research and information center devoted to economic botany. Covers 124 species, with an extensive bibliography; the entry for each species is a minor essay, with detailed treatment under Description, Origin and Distribution, Varieties, Climate, Soil, Propagation, Culture, Keeping Quality, Pests and Diseases, Food Uses, Other Uses. The approach is global -- Uses, for instance, covers the practices of traditional peoples throughout the world, including medical uses. Ms Morton provides a real wealth of information from her long

experience of the subject. With photographs. Full text online:
http://www.hort.purdue.edu/newcrop/morton/index.html



"Self-Sufficiency Gardening: Financial, Physical and Emotional Security from Your Own Backyard" by Martin P. Waterman, 1995, ISBN 1-55950-135-9
Widely respected horticulturist and journalist Martin P. Waterman has prepared this practical guide for the novice and experienced gardeners. Covers the basics, organic growing, edible landscaping, greenhouses, preserving and storing, non-food and other valuable crops, earning income with your crops, and more. Traditional, time-honoured gardening techniques along with computer-gardening technology. Martin Waterman writes gardening articles for Backwoods Home Magazine, among others. This is what the magazine's publisher Dave Duffy said about this book: "If you're going to read just one gardening book in the 90s, this is the book Backwoods Home Magazine will stand behind." From Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=1-1559501359-2
From Safety Central:
http://www.safetycentral.com/selgarbymarp.html



"Chickens in Your Backyard: A Beginner's Guide" by Rick and Gail Luttmann, 1976, Rodale, ISBN 0878571256
Perfect for beginners, steers you round all the traps. Presupposes no prior knowledge, step-by-step style, and it's written with some wit. This was our first chicken book and we found we could rely on it -- though it's not quite as effective as one reviewer claimed: "It will have you laying eggs in days!" The chickens did, but not us! From Rodale Store:
http://WWW.rodalestore.com/webapp/commerce/servlet/ProductDisplay?merchant_rn=15336&prrfnbr=13359
From Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=62-0878571256-0

Chickens in the Garden, by Katie Thear of Country Smallholding Magazine: A Beginner's Guide to Keeping Chickens. Deals with the most frequently asked questions from prospective poultry keepers through the magazine, and from Katie Thear's poultry talks in different parts of Britain. This is a good place to start. Online:
http://www3.mistral.co.uk/cgs/chickens.htm

Resources for Community gardening

American Community Gardening Association (ACGA) -- Information centre, programs, publications, links, newsletter, Locate A Garden, Greening Events, and more.
http://www.communitygarden.org/index.html

"Cultivating Community: Principles and Practices for Community Gardening as a Community-Building Tool" by Karen Payne and Deborah Fryman, American Community Gardening Association (ACGA) -- Explores basic principles and values of successful community empowerment programs of any kind, and illustrates how these principles have been applied to community gardens across the US. Useful tips on how to approach community gardening as an organizing tool, highlights specific practices and activities that have been proven to work. Stories and case studies from community gardens around the US. Order online:
http://www.communitygarden.org/pubs/index.html#Cult

"Growing Communities: How to Build Community Through Community Gardening" by Jeanette Abi-Nader, David Buckley, Kendall Dunnigan and Kristen Markley, American Community Gardening Association (ACGA) -- An in depth exploration of the practices and strategies community organizers can use to develop dynamic leaders and create strong programs using a participatory approach to community building. 300+ page curriculum builds on the work of Cultivating Community and years of ACGA experiences, especially those of the From the Roots Up mentorship and training program. Includes a set of workshop curricula for training on each topic, based on actual FTRU workshops. Appendix with resources lists, handouts and other useful information.
http://www.communitygarden.org/pubs/index.html#Grow

"What Good Is Community Greening? -- Research Supports All Those Common Sense Answers You've Been Using for Years -- but There Is Still More to Learn" by David Malakoff --
http://www.communitygarden.org/pubs/whatgood.html

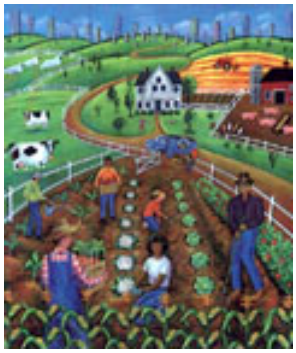
"How Does Our garden Grow: A Guide to Community Garden Success" by Laura Berman, FoodShare Community Gardening Co-ordinator, FoodShare, Toronto -- An extensive manual on community gardening and community organizing. The manual addresses various aspects of community organizing including fundraising, organizational structure, leadership, suggested rules and regulations for peaceful co-existence among gardeners, site acquisition and site selection, as well as site design, maintenance guidelines, tools and equipment, gardening with children and for people with disabilities. Appendices provide horticultural information, composting and soil testing fact sheets and reference and resource lists. Detailed "month by month" sections provide

succinct startup information for any community garden, regardless of location. For more information, contact laura@foodshare.net.To order, contact zola@foodshare.net.

FoodShare Toronto -- Working with communities to improve access to affordable, nutritious food. Non-profit food security organization based in Toronto, Canada: "Growing food in our cities, right where we live, is something that we need to do. Not sometime in the future but right now, before we forget how or the land is put to 'better' use by being paved over or built upon." Community Gardening Program: Since 1986 FoodShare has been helping community groups and individuals to start and sustain community gardens. FoodShare's expert program staff can help with all aspects of community garden development. FoodShare sponsors the Toronto Community Garden Network and publishes the Toronto Community Garden Network E-News weekly email newsletter (online archives); the Field to Table Urban Agriculture Project demonstrates new and innovative ways to grow food in cities; the Good Food Box non-profit fresh fruit and vegetable distribution system, distributes 4,000 boxes per month through 200 neighborhood-based drop-offs. Fact-sheets, resources, publications, information and more.
http://www.foodshare.net/

Community Gardens FAQ by **Foodshare** Toronto:
http://www.foodshare.net/grow-cgfaq.htm

Community Gardening Listserve -- Mailing list operated by the American Community Gardening Association (ACGA), for Community Gardeners, Community Organizers, Master Gardeners and others interested in developing or enhancing community gardening programs to communicate via email. Discussion topics range from fund raising to soil improvement to keeping gardeners motivated. Subscribe online:
https://secure.mallorn.com/mailman/listinfo/community_garden
Community Gardening Mailing list Archives:
http://www.mallorn.com/lists/community_garden/



The US non-profit **Community Food Security Coalition** (CFSC) is dedicated to building strong, sustainable, local and regional food systems that ensure access to affordable, nutritious, and culturally appropriate food for all people at all times. Seeks to develop self-reliance among all communities in obtaining their food and to create a system of growing, manufacturing, processing, making available, and selling food that is regionally based and grounded in the principles of justice, democracy, and sustainability. CFSC has over 250 member organizations, and has awarded $13 million in grants to 102 projects.
http://www.foodsecurity.org/

Seeds of Change: Strategies for Food Security for the Inner

City, Linda Ashman, et. al., UCLA Urban Planning Dept., 1993 -- This landmark report documented the extent of inner-city hunger in Los Angeles. The product of a year's work for six researchers, it is perhaps the most thorough documentation of an urban community's food system. Sections on hunger, nutrition, food industry, supermarket industry, communmity case study, farmers' markets, urban agriculture, joint ventures, and food policy councils. Order online: http://www.foodsecurity.org/pubs.html

A Guide to Community Food Projects, Maya Tauber and Andy Fisher, 2002 -- This 20-page guide features case studies of seven diverse and innovative projects funded by USDA's Community Food Projects grant program. It also includes basic information about the CFP program and sources for more information. The CFP program goals are to meet the needs of low-income people by increasing their access to fresher, more nutritious food supplies; increase the self-reliance of communities in providing for their own food needs; and promote comprehensive responses to local food, farm, and nutrition issues. Acrobat file, 494Kb. http://www.foodsecurity.org/cfsc_case_studies.pdf

Urban Agriculture and Community Food Security in the United States: Farming from the City Center to the Urban Fringe, prepared by the Urban Agriculture Committee of the Community Food Security Coalition (CFSC), February, 2002, Katherine H. Brown, contributors: Martin Bailkey, Alison Meares-Cohen, Joe Nasr, Jac Smit, Terri Buchanan, editor: Peter Mann -- 11,000-word report, online or Acrobat file: The Quiet Revolution of Urban Agriculture in the United States, Food Insecurity in U.S. Cities, Urban Agriculture Builds on the Resources of Cities, The Potential for Growing Food in Cities, Who Is Raising Food in Cities?, Challenges Facing Urban Agriculture and Responses to these Challenges, Policy Changes to Promote Urban Agriculture, Resources, Publications, Websites http://www.foodsecurity.org/urbanag.html

Seeds of Hope...Harvest of Pride! -- Useful set of resources for community gardeners from Ohio State University Extension's Urban Gardening Program. http://www.bright.net/~gardens/

"Starting a Community Garden" -- this fact sheet is designed to give many different groups the basic information they need to get their gardening project off the ground. http://www.communitygarden.org/pubs/starting.html

"What are the Benefits of Community Gardening?" -- adapted from a 1995 Monograph by the American Community Gardening Association, from Seeds of Hope...Harvest of Pride! -- Ohio State University Extension's Urban Gardening Program. A good outline of the many benefits for urban communities and their members. Useful for persuading a local authority.

http://www.bright.net/~gardens/benefits.html

"What Good Is Community Greening?" by David Malakoff: "Research supports all those common sense answers you've been using for years -- but there is still more to learn." 3,500-word online article covers People-Plant Interactions, Background Theories, How Individuals Respond, Plants and Communities, Building Communities, "Greenlining", and more. From the American Community Gardening Association (ACGA).
http://www.communitygarden.org/pubs/whatgood.html

The British **Foundation for Local Food Initiatives** promotes the growth of healthy local food economies, as a key contribution to sustainable development. Home of FLAIR -- the Food and Local Agriculture Information Resource, a partnership project led by the Foundation to analyse the scale, scope and benefits of the local food sector in the UK, to help create a national database, and to enable the development of a national food links network. Local Food News monthy email newsletter, online and archives, directories, reports, case studies, contacts and links.
http://www.localfood.org.uk/

The **Federation of City Farms and Community Gardens** is a UK organisation representing groups involved in community-led development of open space through locally managed farming and gardening. News and events, city farm and community garden directories, resources and publications, how to start a city farm, kids' corner, links and contacts, special resources for members.
http://www.farmgarden.org.uk

City farms

Resources for city farms

Organic gardening

Building a square foot garden
Plant spacing guides
No ground? Use containers
When to sow what
Seeds
Garden pond
Gardening resources

Composting

Making compost
Composting resources
Composting indoors

Vermicomposting
Humanure
Composting for small farms

Small farms

Small farm resources
Community-supported farms
Farming with trees
Farming with animals
Pasture
Pigs for small farms
Poultry for small farms
Aquaculture for small farms
Composting for small farms
Controlling weeds and pests

Small farms library

Community development | Rural development
City farms | Organic gardening | Composting | Small farms | Biofuel | Solar box cookers
Trees, soil and water | Seeds of the world | Appropriate technology | Project vehicles

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City farms
Organic gardening
Journey to Forever organic garden
Handmade soil
Village development
Why organic?
Do it for selfish reasons
No pesticides
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Why organic?

Never mind all the high ideals: do it for selfish reasons. Some people say: "But it's so much more trouble." In fact it's so much less trouble to work with nature than to fight it. Why turn your garden into a battleground -- a battle you can't possibly win? And why poison your food?

> -- "We abuse the land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect." -- Aldo Leopold, author of the environmental classic "Sand County Almanac"

And when you apply that lesson in your garden, lo and behold, nature suddenly becomes your friend and ally, doing most of the work for you.

Sir Albert Howard

What about pests? Don't you need pest-killers? "The pests are my professors," famously wrote **Sir Albert Howard**, founding father of the organics movement -- pest attack simply showed him where the soil fertility needed attention. He'd fix it, the pests would vanish. Not just a fairytale -- any good organic grower will confirm it.

It's not just "muck and magic", it's a lot more scientific than trying to kill everything with deadly poisons -- including beneficial predators that kill pests. Healthy plants have good resistance to pests (like healthy people), but they have to be well-fed for that (also like people), and they get their food from the soil (again like people). If it's not in the soil, the plants won't be healthy (and nor will the people). So feed the soil.

The essence of organic growing is soil management and fertility maintenance: feed the soil, not the plant -- the soil will feed the plant very much better than you can.

Weeds? What's a weed? Same as a pest really: an expert can diagnose an ailing soil's deficiencies and imbalances merely by seeing what weeds are growing in it. They're there for a purpose, well summed-up in the title of a wise book called **Weeds -- Guardians of the Soil** by Joseph Cocannouer.

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Fighting weeds is futile. Some grow to cover an exposed soil that's vulnerable to erosion and run-off -- nature hates exposed soil.

The Journey to Forever garden

So cover it yourself, with a mulch.

Other weeds are deep-rooting plants that go down to the subsoil to collect fresh minerals when the topsoil runs out of them. Composting will fix that -- but leave some of the deep-rooting weeds (herbs actually) growing here and there to open up the soil, your vegetables will appreciate it (so will the earthworms). But they're stealing soil nutrients from your plants? Then your soil *is* in a bad way! -- certainly not fertile enough for vegetables. Believe the weeds! Tend to the soil and they'll stop pestering you, they'll be easy to manage.

No pesticides

Rotenone is a safe and effective organic insecticide (biocide, pesticide) derived from derris roots, used by traditional societies in the east for centuries and approved for use by all organic associations. The effects are not persistent, it is biodegradeable and breaks down quickly into harmless by-products, and it is harmless to birds and mammals.

But most organic growers don't use it: less than 6% of the respondents to a US Department of Agriculture survey of certified organic vegetable growers reported using rotenone (American Journal of Alternative Agriculture, Vol. 13, No. 2, 1998).

"I don't think we are unique among experienced organic growers in using very little intervention in pest management." (Organic grower, US)

"I, too, use no biocides. People who think you have to use biocides to farm assume incorrectly that organic farmers use botanical biocides. This is not the case. Very few organic farmers merely switch from synthetic to organic biocides. For some this may be a first step in the transition to organic

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growing, but it is not the rule. Organic farmers have shown that food crops can be grown with the same or more production per acre, with the same or less lost to pests, without using biocides or NPK (chemical) fertilizers." (Organic grower, US)

> -- "Pesticides are the badge of the amateur" --
> organic grower

Food quality

In these days of successive food scares, food quality and food safety are prime reasons for growing your own: you use good seeds, and you know there are no toxic residues in your crops. But how do you measure quality?

"Nothing beats the fresh taste," says Britain's HDRA organics association. "You can grow for flavour. Commercial growers have to grow for shelf-life."

Keith once visited the HDRA's headquarters at Ryton Gardens in Coventry with a graphic designer, who was there to work, not because he was interested in organics. We had lunch at the HDRA's restaurant, supplied with fresh food from the organic demonstration gardens, and that's when it hit him: he couldn't believe the flavour.

"I haven't tasted food like this since I was a child," he said. "I thought it was because I'd lost my sense of taste as I got older."

Fresh crops from the Beach House garden on the kitchen table

Visitors say similar things when they eat food from our garden. Flavour is a good measure of overall quality -- it's a subjective measure, but it's backed by evidence.

"Study Finds Far Less Pesticide Residue on Organic Produce", New York Times, May 8, 2002 -- The first detailed scientific analysis of organic fruits and vegetables, published today, shows that they contain a third as many pesticide residues as conventionally grown foods.
http://www.nytimes.com/2002/05/08/science/08PEST.html?ex=1065240000&en=70dacc40e18ace2b&ei=5070

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The report: **"Pesticide residues in conventional, IPM-grown and organic foods: Insights from three U.S. data sets"**, by Brian P. Baker, Charles M. Benbrook, Edward Groth III, and Karen Lutz Benbrook, published in *Food Additives and Contaminants*, Volume 19, No. 5, May 2002, pages 427-446. 10 tables, 39 references.

Brix levels

Refractometers are simple, hand-held optical instruments that measure the percentage of sugar in plant juices (the "Brix" level) -- you put a leaf in a garlic crusher, squeeze some juice out onto the prism, and hold it up to the light to get the percentage.

A plant's mineral and protein content, and protein quality, are directly related to the sugar content in the sap. So the refractometer is a reliable, quick and cheap quality test. It's also been shown that plants with high sugar levels are much less prone to pest attack -- healthy plants have good resistance. And they taste better! (See **No sugar** for more on Brix and food quality.)

Standard sugar levels have been worked out for most crops, ranging from "Poor" to "Excellent". Here are some recent readings taken in Hong Kong:

Standard Brix levels

	Poor	Average	Good	Excellent
Cabbage crops, beet, etc	6%	8%	10%	12%
Lettuce	4%	6%	8%	10%

Mui Wo market January 2000

Baak choi (Chinese white cabbage) 3%
Kai laan choi (Chinese kale) 5%
Choi sum (flowering Chinese cabbage) 5%
Lettuce 3%

Hong Kong supermarket January 2000

Baak choi (Chinese white cabbage) 5.5%

Choi sum (flowering Chinese cabbage) 5.5%
Kai laan tsoi (Chinese kale) 7%

Kai laan choi -- Chinese kale (Geoffrey Herklots)

Pearl River Delta, Guangdong January 2000
Celery cabbage (Chi hi li) 3%

Traditional Chinese farms, Lantau Island (average)
Baak choi (Chinese white cabbage) 1.5--2.5%
Choi sum (flowering Chinese cabbage) 2--3%

Private gardens in Lantau, Hong Kong
Garden #1

No chemicals used, poor soil maintenance, no composting
Baak choi (Chinese white cabbage) 2.5%
Choi sum (flowering Chinese cabbage) 2%

Baak choi -- Chinese white cabbage (Geoffrey Herklots)

Garden #2
No chemicals used, poor soil maintenance, small amounts of poor-quality compost used
Baak choi (Chinese white cabbage) 3.5%
Choi sum (flowering Chinese cabbage) 3%

Journey to Forever garden January 2000
Baak choi (Chinese white cabbage) 11%
Kai laan choi (Chinese kale) 12.5%
Silver beet 9.5%

Don't think it's just Hong Kong that has poor vegetables. We've found similar results in London, Plymouth, Glasgow, Amsterdam, Stockholm, New York, Cape Town, Johannesburg. Commercial vegetables are poor quality -- and usually not even that. Seldom do they rate "average", rarely "good".

And that's the best reason to grow your own.

See also: **The case for organics: Scientific studies and reports**

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Scientific studies and reports

Effect of Agricultural Methods on Nutritional Quality: A Comparison of Organic with Conventional Crops, Virginia Worthington MS, ScD, CNS, Johns Hopkins University, Baltimore, 1998, Alternative Therapies, Volume 4, 1998, pages 58-69 -- Virginia Worthington reviewed available research comparing the nutritional value of organically grown and conventionally grown produce. She concluded that organic produce is nutritionally superior. She compared the composition of vegetables grown simultaneously under different farming conditions, conducting 41 studies with 1,240 comparisons of 35 vitamins and minerals. Organically grown produce was higher in most minerals and vitamins and lower in potentially harmful nitrates, which result from nitrogen fertilizers. The greatest differences among all vegetables tested were in magnesium (organic was 29% higher), vitamin C (27% higher), and iron (21% higher). In fact, organic food had higher amounts of all minerals tested, although the difference was not always statistically significant because of small sample numbers. Organic crops had 15% fewer nitrates than conventionally grown foods and lesser amounts of toxic heavy metals. Worthington also investigated the effect of routine consumption of organically grown fruits and vegetables on the nutritional adequacy of the overall diet. Using the USDA recommendation of five servings of fruits and vegetables a day, she determined that consuming organically grown produce might make the difference between a deficient and an adequate diet. See **Is Organically Grown Food More Nutritious?** Virginia Worthington, 1998 -- condensed version of "Effect of Agricultural Methods on Nutritional Quality: A Comparison of Organic with Conventional Crops": http://www.mindfully.org/Food/Organic-More-Nutritious-WorthingtonNov01.htm

Nutrition and Biodynamics: Evidence for the Nutritional Superiority of Organic Crops, Virginia Worthington MS, ScD, CNS, Johns Hopkins University, Baltimore, July/August, 1999, Biodynamics v.224 http://www.mindfully.org/Food/Organic-Crops-Superior-WorthingtonJul99.htm

Nutritional Quality of Organic Versus Conventional Fruits, Vegetables, and Grains, Virginia Worthington, M.S., Sc.D., C.N.S., 2001, Journal of Alternative and Complementary Medicine Volume 7, Number 2, pp. 161–173. Abstract: http://haly.ingentaselect.com/vl=1370482/cl=23/nw=1/rpsv/catchword/mal/10755535/v7n2/s7/p161

Full report (Acrobat file, 176 kb)

Pesticide residues in conventional, IPM-grown and organic foods: Insights from three U.S. data sets, by Brian P. Baker, Charles M. Benbrook, Edward Groth III, and Karen Lutz Benbrook, May 2002, Food Additives and Contaminants, Volume 19, No. 5, pages 427-446 -- Consumers who buy organic fruits and vegetables are exposed to just one-third as many residues as they'd eat in conventionally-grown foods, and the residues are usually lower as well, according to a new scientific study -- the first detailed analysis of pesticide residue data in foods grown organically and

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conventionally. The authors analyzed test data on pesticide residues in organic and non-organic foods from three independent sources covering more than 94,000 food samples from more than 20 different crops; 1,291 of those samples were organically grown. USDA data showed that 73% of conventionally grown foods had at least one pesticide residue, while only 23% of organically grown samples of the same crops had any residues. Conventionally-grown crops were six times as likely as organic to contain multiple pesticide residues. California data found residues in 31% of conventionally grown foods and only 6.5% of organic samples, and found multiple residues nine times as often in conventional samples. Consumers Union tests found residues in 79% of conventionally grown samples and 27% of organically grown samples, with multiple residues 10 times as common in the former. The levels of residues found in organic samples were also consistently lower than levels of the same pesticides found in conventional samples, in all three sets of data. When residues of persistent, long-banned organochlorine insecticides such as DDT were excluded from the analysis of the USDA data, the fraction of organic samples with residues dropped from 23 to 13%. Most residues in organic foods are unavoidable results of environmental contamination by past pesticide use or by spray "drift" from adjacent non-organic farms. See **Summary**

"Study Finds Far Less Pesticide Residue on Organic Produce", New York Times, May 8, 2002: http://www.nytimes.com/2002/05/08/science/08PEST.html?ex=1065240000&en=70dacc40e18ace2b&ei=5070

Why Food Safety Will Continue Driving Growth in Demand for Organic Food, Charles M. Benbrook -- Remarks prepared for the 2003 EcoFarm Conference, Monterey, California, on January 24, 2003. Message from Dr Benbrook to the Sustainable Agriculture Network Discussion Group, 27 Jan 2003: "I presented a paper last week at the EcoFarm conference at Asilomar. It was on pesticide residues in organic vs. conventional food. It includes new data from 1999-2000 Calif. DPR testing [U.S. Department of Pesticide Regulation], as well as 2001-2002 British testing (they found the same basic pattern of residues as U.S. testing programs). It argues that on the food safety-pesticide front, the scientific case is now rock solid that consuming organic food is a reliable way to markedly reduce pesticide dietary exposures, and hence risk; and second, that recent toxicological and epidemiological studies strongly support the conclusion that for pregnant women, infants, and children, current levels of exposure in the diet cannot be defended as safe. This is the basic conclusion reached by the [U.S.] EPA in its cumulative risk assessment of the OPs [organophosphorus pesticides], and why further regulatory actions on high-risk OPs are needed." **Full report** (Acrobat file, 220 kb)

Organic Diets Linked to Lower Pesticide Levels in Children, 7 March 2003: Organic food reduces pesticide residues in children A study of two to five-year olds in the US has found that consumption of organic food can have a significant effect on children's pesticide exposure. Scientists at the University of Washington investigated 43 children from the Seattle area who either ate mostly conventionally grown or organic fresh fruit and vegetables and fruit juices. The children eating primarily organic diets had only one-sixth the level of organophosphorus pesticide metabolite concentrations compared with those eating conventional diets. Other possible sources of pesticides were found not

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to have an impact on the study's results. Dosage estimates showed that consuming organic produce reduced the children's exposure levels from above to below the U.S. Environmental Protection Agency's safety levels, shifting their exposures from "uncertain risk" to "negligible risk". Other studies back up the researchers' claims. A 2001 study found that of 110 urban and suburban children, all but one of the children had measurable levels of organophosphorus pesticide metabolites in their urine. The one exception was a child who ate only organic food.
http://www.edie.net/news/Archive/6735.cfm

Organophosphorus Pesticide Exposure of Urban and Suburban Preschool Children with Organic and Conventional Diets, Cynthia L. Curl, Richard A. Fenske, Kai Elgethun, Environmental Health Perspectives v.111, n.3, March 2003 -- Abstract:
http://ehpnet1.niehs.nih.gov/docs/2003/5754/abstract.pdf
Full report:
http://www.mindfully.org/Pesticide/2003/Children-Organic-Conventional-Mar03.htm

(EPA and USDA reports show that by the time the average child is one year old, the infant will have received the acceptable lifetime dose of eight pesticides from just 20 commonly eaten foods. The Environmental Working Group (non profit research institute) reports that children may receive 35% of their lifetime dose of carcinogenic pesticides by the age of 5. A USDA study (April 94) tested 6,000 produce items (12 kinds of produce) and pesticide residues (49 different pesticides) were found on 61% of the samples. All items were prepared for human consumption (washed, peeled or cored) before being tested.)

Food Safety and Quality as affected by Organic Farming, Food and Agriculture Organisation (FAO), Report of the 22nd regional Conference for Europe, Portugal, 24 to 28 July 2000: "With respect to chemicals, organic agriculture differs from conventional agriculture as it refrains from using synthetic agricultural inputs, such as synthetic pesticides, herbicides, fertilisers, fungicides, veterinary drugs (e.g. antibiotics, growth hormones), synthetic preservatives and additives, and irradiation. Thus, potential hazards posed by synthetic input residues are prevented, to the extent possible. This underlies consumer expectations that organic foods are healthier. It has been demonstrated that organically produced foods have lower levels of pesticide and veterinary drug residues and, in many cases, lower nitrate contents. Animal feeding practices followed in organic livestock production, also lead to a reduction in contamination of food products of animal origin."
http://www.fao.org/docrep/meeting/X4983e.htm

Studies comparing the health effects of organic and non-organic feed on animals have found clear positive health effects of organic feed:

- Experiment 1: reduced sperm motility in bulls transferred from organically to non-organically grown fodder. Motility was restored when organic fodder was resumed. Experiment 2: greater number of eggs (nine versus three and six) and higher fertilisation rate (100 per cent versus 29 and 26 per cent) in rabbits fed organically versus non-organically fertilised feed. (Aehnelt & Hahn, 1978). Aehnelt E and Hahn J, 1978, 'Animal fertility: a possibility for biological quality assay of fodder and

feeds', Biodynamics 25, p 36–47

- Almost all fertility and growth criteria tested, including total number of perinatal young, number of living perinatal young, live weight at birth, and number and weight of young at day 90, showed significantly better results for the organically fed rabbits than the non-organically fed rabbits. Edelmuller I, 1984, 'Untersuchungen zur qualitatserfassung von produkten aus unterschiedlichen anbausystemen (biologisch-dynamisch bzw. konventionell) mittels futterungsversuchen an kaninchen', dissertation, University of Vienna, Austria
- The use of organically grown feeds led to higher pregnancy rates, more embryos, larger litters and better health of rabbits over three generations, in spite of the fact that the feed pellets for the two groups were shown to be identical in terms of known essential and harmful ingredients. The fertility rate of rabbits declined over three generations in rabbits fed non-organically grown feed. Staiger D, 1988, 'The nutritional value of foods from conventional and biodynamic agriculture', IFOAM Bulletin No. 4, p 9–12
- Better weight gain after coccidial illness and fewer incidents of illness in chickens fed organically grown feed; significantly higher egg weight, yolk weight and body weight at 32 weeks in organically fed chickens compared with birds fed chemically fertilised feed. Plochberger K, 1989, 'Feeding experiments. A criterion for quality estimation of biologically and conventionally produced foods', Agriculture, Ecosystems and Environment 27, p 419–428
- Fewer stillbirths and perinatal deaths in first litters in rats fed organically grown feed versus non-organically grown feed over a period of three generations. The rats fed organic food had a greater capacity to compensate weight loss during and after lactation and gained more weight. Velimirov A, Plochberger K, Huspeka U and Schott W, 1992, 'The influence of biologically and conventionally cultivated food on the fertility of rats', Biol Agric Hort 6, p 325–337

"In Pfeiffer's experiments the number of mortalities among 80 mice fed organic grains was about half of that among 80 mice fed mineral-fertilized grain (about 9% vs. 17%). Both groups preferred the organically grown wheat (90% of the time). Chickens on organic grain began laying earlier, and at faster rates. They laid twice as many fertile eggs, and the eggs kept better." (Pfeiffer, E.E. Soil Fertility: Renewal, and Preservation. New York: Trans. F. Heckel. Anthroposophic Press, 1938.) -- From **Nutritional Characteristics of Organic, Freshly Stone-ground, Sourdough & Conventional Breads**, Judy Campbell, B.Sc., Mechtild Hauser, and Stuart Hill, B.Sc., Ph.D., P.Ag., Ecological Agriculture Projects, McGill University (Macdonald Campus), Canada, EAP Publication - 35
http://eap.mcgill.ca/Publications/eap_foot.htm

Long-Term Field Experiment in Sweden: Effects of Organic and Inorganic Fertilizers on Soil Fertility and Crop Quality, Artur Granstedt and Lars Kjellenberg, Proceedings of an International Conference in Boston, Tufts University, Agricultural Production and Nutrition, Massachusetts March 19-21, 1997. An agricultural field experiment began in Järna, Sweden, in 1958 that lasted until 1990 -- 32 years. It included eight different fertilizer treatments, each with a four-year crop rotation without repetitions: summer

wheat, clover/grass mix, potatoes, beets. The focus was primarily on aspects of crop quality, and the fertilizer application rates for the various treatments were adjusted to bring about comparable yields. Two "daughter experiments" were run in parallel during 1971-1976 and 1971-1979. The experiments compared two systems, biodynamic farming and conventional farming. Compared with the conventional treatments, the crude protein content of potatoes and wheat was lower in the organic treatments, but protein quality was higher (i.e. relatively pure protein and essential amino acids, lower amount of free amino acids). Resistance to decomposition and store quality for potatoes were higher in the organic treatments, and in wheat starch quality seemed to be higher. The organic treatments resulted in a higher soil fertility capacity and in crops with higher quality protein, a higher starch content, and a greater ability to tolerate stressful conditions and long-term storage than the inorganic treatments. The organic crops developed a structure that, studied through a picture formation method (Crystallization with CuCl2), shows a higher organizational level which is evident in terms of both soil and crop formation as a result of the long-term effects of organic manure compared with conventional NPK-fertilizer.
http://www.jdb.se/sbfi/publ/boston/boston7.html

Organically grown foods higher in cancer-fighting chemicals than conventionally grown foods, American Chemical Society, 4 March 2003 -- Fruits and vegetables grown organically show significantly higher levels of cancer-fighting antioxidants than conventionally grown foods, a new study suggests. The research found that pesticides and herbicides actually thwart the production of phenolics -- chemicals that act as a plant's natural defense and also happen to be good for our health. The study by UC Davis researchers measured antioxidants found in corn, strawberries and a type of blackberry called a marionberry. The results showed a significant increase in antioxidants in organic and sustainably grown foods versus conventionally grown foods: corn was 58.5% higher, marionberries were about 50% higher, strawberries about 19% higher.
http://www.sciencedaily.com/releases/2003/03/030304073059.htm
Full study: **Comparison of the Total Phenolic and Ascorbic Acid Content of Freeze-Dried and Air-Dried Marionberry, Strawberry, and Corn Grown Using Conventional, Organic, and Sustainable Agricultural Practices**, Danny K. Asami, Yun-Jeong Hong, Diane M. Barrett, and Alyson E. Mitchell, Department of Food Science and Technology, University of California-Davis, March 3, 2003, Journal of Agricultural and Food Chemistry 51 (5), 1237 -1241.
http://pubs.acs.org/cgi-bin/sample.cgi/jafcau/2003/51/i05/html/jf020635c.html
Acrobat file (60kb)
http://pubs.acs.org/journals/jafcau/sample.cgi/jafcau/2003/51/i05/pdf/jf020635c.pdf

Fruits of Success: Organic food is not just tastier and better for the environment, it also makes better business sense, New Scientist, 18 April 2001 -- The first comprehensive study of apple-growing systems provides evidence that there are financial as well as environmental rewards for apple growers who go organic. The study compared the economic and environmental sustainability of conventional, organic and integrated apple production systems in Washington State from 1994 to 1999, analyzing differences in yields, costs, taste, soil quality, energy use and environmental impacts. Headed by soil

scientist John Reganold, the research project planted Golden Delicious apples on four acres loaned by a 50-acre commercial farm in the state's Yakima Valley apple district. Each growing system was tested in four different plots, laid out in a random fashion.The three systems gave similar apple yields. The organic and integrated systems had higher soil quality and potentially lower negative environmental impact than the conventional system. The organic orchard was more energy efficient than the conventional and integrated systems, requiring less labour and less water per apple produced. The organic system produced sweeter and less tart apples, higher profitability and greater energy efficiency. The organic system ranked first in environmental and economic sustainability, the integrated system, using a combination of organic and conventional techniques, ranked second and the conventional system last.
http://www.newscientist.com/news/news.jsp?id=ns9999642
Comment by **Pesticide Action Network North America** (PANNA):
http://www.panna.org/panna/resources/panups/panup_20010810.dv.html
Sustainability of three apple production systems, John P. Reganold, Jerry D. Glover, Preston K. Andrews & Herbert R. Hinman, 19 April 2001, Nature 410, 926 - 930 -- Abstract:
http://www.nature.com/cgi-taf/DynaPage.taf?file=/nature/journal/v410/n6831/abs/410926a0_r.html

Organic Food and Farming: Myth and Reality, Soil Association and Sustain, 2001 -- Counters the myths spread by the opponents of organic food and farming. Endorsed by 36 public interest groups ranging from the National Federation of Women's Institutes to WWF-UK. Myth 1: Myth Organic foods are no healthier than non-organic foods. Reality Wrong: food produced organically contains fewer contaminants. Some scientific studies have shown that there are more nutrients in organically produced food. Useful summary of research findings, with references. (Acrobat PDF, 32 pages, 154k)
http://www.soilassociation.org/web/sa/saweb.nsf/24ffc96e2350a4e680256ab10047def0/0f72781fb39de61880256ae4005dea9b/$FILE/Myth&Reality.pdf

Organic Foods vs Supermarket Foods: Element Levels, by Bob L. Smith, 1993, Journal of Applied Nutrition, Vol 45-1 -- Over a two-year period, organically and conventionally grown apples, potatoes, pears, wheat, and sweet corn were purchased in the western suburbs of Chicago and analyzed for mineral content. Four to 15 samples were taken for each food group. On a per-weight basis, average levels of essential minerals were much higher in the organically grown than in the conventionally grown food. The organically grown food averaged 63% higher in calcium, 78% higher in chromium, 73% higher in iron, 118% higher in magnesium, 178% higher in molybdenum, 91% higher in phosphorus, 125% higher in potassium and 60% higher in zinc. The organically raised food averaged 29% lower in mercury than the conventionally raised food. See **Full report**

Effect Of Diets Based On Foods From Conventional Versus Organic Production On Intake And Excretion Of Flavonoids And Markers Of Antioxidative Defense In Humans, Lisbeth Grinder-Pedersen, Salka E. Rasmussen, Susanne Bügel, Lars V. Jørgensen, Lars O. Dragsted, Vagn Gundersen, and Brittmarie Sandström, August 2003, Journal of Agricultural and Food Chemistry, 51 (19), 5671 -5676 -- Danish

scientists have substantiated a nutritional difference between organic and conventional vegetables. They found that organically grown vegetables have a higher concentration of flavonoids -- natural antioxidants. The study was a double-blinded randomised, human crossover intervention study with strict control of dietary intake. Test-persons were given organic food and conventional food in turn for periods of 3 weeks. During the test-periods blood and urine samples were collected and tested for the intake and excretion of five selected flavonoids and effect on markers of oxidative defense. The study was conducted by The Institute of Food Safety and Nutrition under The Danish Veterinary and Food Administration; The Department of Human Nutrition and Centre for Advanced Food Studies under The Royal Veterinary and Agricultural University; and Risø National Laboratory. See **Full report** (Acrobat file, 68 kb)

Organically Produced Foods: Nutritive Content, Mary V. Gold, Alternative Farming Systems Information Center, National Agricultural Library, Agricultural Research Service, U.S. Department of Agriculture, June 2000 -- Bibliography on the nutritive value of organically produced foods: vitamin and mineral content, as well as related chemical constituents. A few references deal with the general relationship of soil qualities and crop composition, all documents cited contain information about nutrients found in food as related to organic production. Most are research results, some are overviews of literature or research, many compare organic foods with those conventionally produced. 216 documents cited. Special Reference Briefs Series no. SRB 2000-03
http://www.nal.usda.gov/afsic/AFSIC_pubs/srb0003.htm

Research by the **Organic Advisory Service of the Organic Retailers & Growers Association of Australia** (ORGAA) compared nutrient content of organic and conventionally grown vegetables. Four vegetable varieties, tomatoes, beans, capsicums and silver beet, were grown on a certified organic farm using compost and soil regenerative techniques and were later analysed for vitamin and mineral elements. A similar range of vegetables grown conventionally was sampled and analysed from a supermarket. Results showed significant differences in mineral levels in favour of the organic produce. Calcium levels in some produce increased by eight times, potassium by ten times, magnesium by seven times and zinc by five times. See "**Food with Attitude**", *Permaculture International Journal* (March-May 2000, No. 74, ISSN 1037-8480), p.27.

	Beans	Tomatoes	Capsicum	Silver Beet
Calcium S	40	6.7	4.7	6
Calcium O	480	67	84	1600
Potassium S	260	200	150	450
Potassium O	1900	300	1600	2600
Magnesium S	26	10	11	69
Magnesium O	240	89	700	1700
Sodium S	<1	2.4	<1	180
Sodium O	<10	26	20	1800
Iron S	0.6	<0.5	<0.5	1.4
Iron O	<5	<5	<5	9.4

Zinc S	0.38	0.19	0.13	0.57
Zinc O	3.4	1.2	2.5	130

S-supermarket produce, O-organic/revitalized soil, mg/kg
Australian Government Analytical Laboratory

"Organic Farming, Food Quality and Human Health", the Soil Association, Bristol, UK. Key findings: "The evidence from properly conducted scientific studies shows that on average organic food is better for you than non-organic food: It's more nutritious. On average our research found higher vitamin C, higher mineral levels and higher phytonutrients -- plant compounds which can be effective against cancer. There's also less water in organic vegetables so pound for pound you get more carrot for your carrot. Tests with people and animals eating organic show it makes a real difference to health. Alternative cancer therapies have achieved good results relying on the exclusive consumption of organic food. Animal feeding trials have shown better reproductive health, better growth, better recovery from illness."
http://www.soilassociation.org/sa/saweb.nsf/9f788a2d1160a9e580256a71002a3d2b/de88ae6e5aa94aed80256abd00378489
Executive Summary:
http://www.soilassociation.org/web/sa/saweb.nsf/848d689047cb466780256a6b00298980/80256ad80055454980256a9d004983d4!OpenDocument
Key findings:
http://www.soilassociation.org.uk/web/sa/saweb.nsf/848d689047cb466780256a6b00298980/80256ad80055454980256a9d005707d8!OpenDocument

Organic food might reduce heart attacks, New Scientist, 14 March 2002 -- Salicylic acid is a chemical signal in plants infected by pathogens and it is responsible for the anti-inflammatory action of aspirin. People who take aspirin have a reduced risk of developing hardening of the arteries and bowel cancer. Dietary salicylic acid may help to prevent these conditions. The study determined the contents of salicylic acid in organic and non-organic vegetable soups purchased from supermarkets. The organic soups had a significantly higher content of salicylic acid, suggesting that the vegetables and plants used to prepare them contained greater amounts of the phenolic acid than the corresponding non-organic ingredients. Consumption of organic foods may result in a greater intake of salicylic acid.
http://www.newscientist.com/news/news.jsp?id=ns99992033
Salicylic acid in soups prepared from organically and non-organically grown vegetables, Baxter GJ, Graham AB, Lawrence JR, Wiles D, Paterson JR, Area Biochemistry Department, Dumfries and Galloway Royal Infirmary, Scotland, Dec 2001, European Journal of Nutrition 40(6):289-92 -- Abstract:
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11876493&dopt=Abstract

Research Shows More Vitamin C In Organic Oranges Than Conventional Oranges, American Chemical Society, June 2, 2002 -- Organically-grown oranges contain up to 30% more vitamin C than those grown conventionally, according to research by Professor Theo Clark of

Truman State University. Conventional oranges are larger than organically-grown oranges, and they have a deeper orange color. Because of their size, "we were expecting twice as much vitamin C in the conventional oranges," said Clark. But to his surprise, chemical isolation combined with nuclear magnetic resonance (NMR) spectroscopy revealed that the organically-grown oranges contained 30% more vitamin C than the conventionally-grown fruits -- even though they were only about half the size. http://www.sciencedaily.com/releases/2002/06/020603071017.htm

The Haughley Experiment was started on Lady Eve Balfour's farm in England in 1939 and continued for 33 years, comparing two similar sections under crops and livestock, one under organic management with no imports (a closed system), and the other the same plus chemical fertilizers and pesticides, with ongoing sample analyses of soil, crops and livestock products, totalling thousands of individual analyses. The experiment had many significant results. The many different chemical analyses revealed no consistent or significant differences between the sections, other than the usually higher water content of the chemically grown fodder. Yet the findings confirmed many reports from organic farmers in different parts of the world, that a given output of animal products -- milk, meat, eggs, etc -- required from 12-15% less input of food when the food was grown organically. For example, though the organic herbal leys (pastures) were of clearly sparser growth than the much lusher chemical section leys, the cows on the organic section gave, over a 20-year period, around 15% more milk. The organic cows also lived longer, and the organic section had far less pest and disease problems. -- See **"Towards a Sustainable Agriculture -- The Living Soil"**, by Lady Eve Balfour, address to IFOAM (International Federation of Organic Agriculture Movements) conference in Switzerland, 1977. **Full report**

-- See also **"The Living Soil"** by Lady Eve B. Balfour, Faber & Faber, London, 1943. Full text online at the Soil and Health Library: http://www.soilandhealth.org/

Organic Crops Competitive with Conventional Systems, May 1999 -- Farm profits from organic cropping systems can equal or exceed profits from conventional rotations in the Midwestern United States, according to a study by the Henry A. Wallace Institute for Alternative Agriculture. The report reviews past and current research on conditions that make growing organic crops profitable, as well as studies that compare organic grain and soybean production with conventional production. The Economics of Organic Grain and Soybean Production in the Midwestern United States, Rick Welsh, policy analyst, Henry A. Wallace Institute for Alternative Agriculture -- full report (Acrobat file, 301Kb): http://www.winrock.org/wallacecenter/documents/pspr13.pdf

Soil Fertility and Biodiversity in Organic Farming, Paul Mäder, Andreas Fliebach, David Dubois, Lucie Gunst, Padruot Fried, Urs Niggli, Research Institute of Organic Agriculture and the Swiss Federal Research Station for Agroecology and Agriculture, May 31, 2002, Science 296:1694-1697 -- A 21-year Swiss study of organic and conventional farming systems provides evidence that large-scale organic farming is economically viable and environmentally sustainable over the long haul. The trial demonstrates that organic crop production is amazingly efficient -- organic

farming produced more food with less energy and fewer resources. Although expenditure on fertilizers and energy was 50% lower and pesticide use was 97% lower, yields of organic crops were only 20% lower on average. Published in Science, May 31, 2002, the study reported that organic farming methods used 50% less energy, 97% less pesticide and 51% less fertilizer than conventional methods. The study, co-sponsored by the Swiss government, began in 1978. The researchers used 96 small plots on a site near Basel, Switzerland, growing potatoes, barley, winter wheat, beets and grass clover. Full report: http://www.mindfully.org/Farm/Organic-Farming-Fertility-Biodiversity31may02.htm

Soil minerals, chemicals and food

Alex Jack, a health writer in Massachusetts, and Anne-Marie Mayer, a nutrition researcher in Britain (now at Cornell), separately compared government reports on the levels of vitamins and minerals in fresh food in the 1990s and from several decades ago. Both revealed significant declines in calcium and iron in a variety of raw fruits and vegetables. Each comparison also noted declines in other nutrients, including vitamins A and C, and potassium.

Alex Jack reported on his comparison of US Department of Agriculture food composition tables from 1975 and 1997 that average calcium levels in 12 fresh vegetables have declined 27%, iron levels have dropped 37%, vitamin A levels, 21%; and vitamin C levels, 30%. "This suggests a steady deterioration in soil, air, and water quality, as well as reduced seed vitality, that is depleting minerals," he said.

Jack took his findings to the US Department of Agriculture (USDA), hoping for a reasonable explanation. After two years, he's still waiting. So is *Organic Gardening* magazine, which published an open letter, seeking an explanation from Dan Glickman, then-Secretary of Agriculture. Glickman didn't respond, but USDA employee Phyllis E. Johnson did. In her letter to *Organic Gardening*, Ms. Johnson said that the nutritional content of produce is not as important as things like appearance and big yield. -- **"Vegetables Without Vitamins"**, LE Magazine, March 2001 http://www.lef.org/magazine/mag2001/mar2001_report_vegetables.html

A similar analysis comparing British nutrient data from 1930 and 1980 indicates reductions of essential minerals in both fruits and vegetables. According to the report, published in the British Food Journal (1997, vol 99, no. 6, pp 207-211), average calcium content has declined 19%; iron, 22%; and potassium, 14% in the 20 vegetables compared. Author Anne-Marie Mayer said: "Agriculture which relies on NPK (chemical) fertilizers and pesticides, that adds little organic matter to the soil and that alternates between soil compaction and ploughing, could produce food depleted in minerals."

The 1999 report on the University of Wisconsin-Madison's ongoing 37-year project monitoring the effects of nitrogen fertilisers in the US concluded that agriculture's continuing overapplication of nitrogen fertilizers is causing irreparable damage to the soil. It said US farms have "a 50% applied nitrogen efficiency rate" -- only half the nitrogen applied to the soil is actually used by the crop. The other half becomes harmful nitric acid. They said three decades of

such overuse of nitrogen has destroyed much of the soil's fertility, causing it to age the equivalent of 5,000 years. -- **"Acidification From Fertilizer Use Linked To Soil Aging"**:
http://www.cals.wisc.edu/media/news/03_99/acid_soil.html

Paul Bergner, in **"The Healing Power of Minerals, Special Nutrients and Trace Elements"** (Prima Publishing, 1997), lists official figures from the US Department of Agriculture showing a fall in the mineral and vitamin contents of fruits and vegetables between 1914 and 1992. From 1963 to 1992, with the use of chemical fertilizers at a peak, calcium levels fell an average 30%, iron 32%, magnesium 21%, phosphorus 11%, potassium 6.5%.

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Building a square foot garden

Where to build it

Journey to Forever Square Foot Garden

If you're already an organic gardener, you probably already have everything you'll need: space for square foot beds, fertile soil, compost, knowledge and experience. If you're a row gardener, these are permanent no-dig beds, no walking on them -- like raised beds, whether you build them raised or flush with the surface. If you're a raised-bed grower, use raised beds. See below, **Sizes and shapes**.

If you have a garden, but you're no expert, or new to growing food, first choose a good site. What makes a good site? Lots of sunshine, and tons and tons of that "well-drained, rich, loamy soil" the seed packets tell you to plant your seeds in, as if the stuff grows on trees. So just choose a good place where there's enough light, we'll fix the soil.

Take up a bit of lawn if you like, the soil under a lawn is usually quite good. Use a sharp spade to cut through the turf: make vertical cuts (use your foot), slicing it up into one-foot squares, then peel the squares off like a carpet.

We broke through the cement patio, dug out lots of beach sand and added LOTS of compost

You only need to take off an inch or two. Pile the squares in a block, grass-side down, wet thoroughly as you go, cover the top with a garbage bag to keep it moist, and it'll rot down into a useful supply of well-drained, rich, loamy soil.

If you have some suitable garden space with fairly soft

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soil you've been using for growing, use that. If all you have is some rough, hard ground, don't despair, it'll do, with a bit more trouble. Put some pegs in the ground and use string to mark where the beds will be (include a 15" path space round the beds), and then cover it with a thick layer of hay, grass clippings, dead leaves, anything that'll make a good mulch. Make it at least six inches thick; if it sinks, add more. Keep it well-watered, and don't let anyone walk on it. After a few weeks the ground will be much softer. Scoop off the mulch (you can use it later, in the garden or in the compost), and you can begin.

If you don't have mulch, use an old carpet, or lots of newspapers or cardboard cartons, or even garbage bags. Give the surface a good sprinkling first (not enough to puddle or muddy it). Keep checking to see the soil is moist, sprinkle again if not.

This is another way of preparing lawn for growing beds rather than removing the turf, though it'll take a while. Carpets work well.

No ground at all? Got a cement patio? A balcony? A rooftop? See below, **Cement**.

Is the soil fertile enough?

No, in a word. You'll need compost, lots of it, equivalent to a 3-6" layer -- 6" or more for really poor, compacted, rough ground. If you don't make compost, see our **composting pages** and give it a try -- it's easy and rewarding, in many different ways!

It's best to have enough compost for the job to hand when you build your beds. Second best is to use what little you have or can lay your hands on, and add more later. You can start growing plants in the meantime and dig more compost into the top few inches around the plants or in empty squares as it's available, using a trowel.

One of the beauties of square foot beds is that you can treat each square foot separately.

You might be able to buy compost at a reasonable price: check with the municipality or your local agricultural extension agent, and the gardening club, if there is one. The so-called potting composts and multipurpose composts you can buy in garden centres are usually not compost at all, they're potting soil

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School and youth programs on the Web

Keith bagging finished compost

mixtures: you want organic compost, made from organic wastes by "hot" composting. Vermicompost -- worm manure -- is even better, but it's expensive.

An alternative is well-rotted manure, if that's really what it is: it should be black, crumbly stuff with an earthy smell, NOT the "farmyard manure" that consists of sticky lumps of dung mixed with bits of straw and hay and smells bad. If you think that's good stuff, as many people will tell you, try feeding it to worms and see what happens (they die). Sir Albert Howard, the founder of organics, saw this stuff as the great weakness of European agriculture and mounted a crusade to reform the odious "manure pile" that produces it. He failed, but believe him!

Raised beds and double-digging

This is the best way of preparing square foot beds. It's hard work, but these beds are small, and if your soil is quite good it won't break your back. If the soil is bad, this is how to fix it once and for all.

Use a sharp, straight-edged, flat-bladed digging spade with a D-handle for double-digging

You need a digging spade and probably a digging fork (or spading fork). D-handled tools are best for this. If the cutting edge of the spade is blunt and burred, sharpen it.

Mark off where you want the beds. Leave space for 15-inch-wide paths. Cover the path area with boards so you don't compact the soil by trampling it too much.

Cover the whole surface of the bed with a layer of compost (up to 2" thick), and sprinkle some ground limestone (or garden lime if you can't get ground limestone) over it -- a thin sprinkling, like icing sugar on a sponge cake.

Start by digging a trench across one end of

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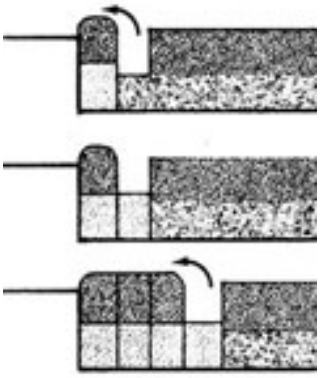
the bed a spade deep and a spade wide. Take thin slices (try half an inch), mixing in the compost as you go. Thin slices are much easier on your back and mix the soil better. Put the soil in a bucket or a wheelbarrow and dump it at the far end of the bed.

Cover the bottom of the trench with another layer of compost sprinkled with lime. If the soil in the bottom of the trench is fairly soft, use the spade to loosen it, again a spade deep, mixing in the compost as much as possible. If it's too hard for a spade, use the fork instead.



Double-digging -- see "How To Grow More Vegetables" by John Jeavons, an excellent resource for intensive growers.

Now dig a second trench alongside the first one (thin slices!), moving the soil into the first trench, mixing it well. Compost the bottom of the second trench, dig it or fork it, then dig a third trench, and so on right down the length of the bed. You're left with an open trench at the end, which you fill with the soil from the first trench.

Now you've loosened and conditioned the soil to a depth of about 16" and added about 4" of compost, and loosening the soil will have added another 2" or so, so the surface of the bed will be about 6" higher than the path.

Paths

Paths are a waste of soil, and as you walk on them you compact the soil underneath, making it difficult for deep-rooting plants in the beds to send their roots out to the sides. This is how to make use of the path soil, and extend the root area from the beds under the paths.

If you're making two parallel beds (see below, **Sizes and shapes**), you'll have three paths, one on either side and one in the middle, plus a short one at each end. Remove the boards and dig out the side paths (thin slices!) to a depth of about 4", spreading the soil on top of the adjacent bed. For the middle path, spread half over one bed and half over the other. Spread the soil from one end path over one bed and from the other over the second.

The sides

The beds are now too high to stand on their own, and making sloping sides that will not fall down will greatly reduce the surface area. Some gardeners make rounded mounds and use the whole area.

New raised beds for the Journey to Forever garden

Better to board up the beds so the sides are sheer and stable, with the whole surface area to grow in.

There's a great debate over which kind of boards are best. We think free boards are best -- recycled container pallets will do, or thicker boards if you can get them. Don't use pressure-treated lumber! It's got arsenic in it and other toxins, and no matter what they might tell you, it will leach out and get into your plants, and quite possibly into you too. There's another debate on how to weatherproof them. Don't use creosote! -- it's a plant poison. Paint or spray them with vegetable oil, or, better, linseed oil. Some linseed oil has toxic preservatives added -- check the label (or use food-grade flaxseed oil, it's the same thing). Or try this 100-year-old recipe for "Everlasting Fence Posts":

"Take boiled linseed oil and stir in it pulverized charcoal to the consistency of paint. Put a coat of this over the timber, and there is not a man that will live to see it rotten." (From "Lee's Priceless Recipes" 1895)

The sides should be about 12-15" high, but use your judgment. When you've built them, spread a third layer of compost on top and hoe it in lightly to condition the path soil.

The soil will settle a bit in time, but it should still leave your plants with an easy root depth of about two feet of highly fertile soil to wiggle their toes in. This will support the kind of cropping intensity and crop quality you require from a square foot garden.

Greens growing happily in the beds

Put more boards on the paths, or flagstones, or gravel. Or fill them with dead leaves or mulch (top up as it sinks). All these will help protect the soil from compaction as you walk on it, while mulching will steadily enrich it -- useful space for deep-rooting vegetables.

Sizes and shapes

The original square foot unit is 4x4ft, 16 sq ft, which can supply one person with vegetables and salads. But many gardeners have found this square block unwieldy. Some people use 3x3ft blocks instead, and this seems to have become a standard size for school gardens using the square foot system.

We've found 3ft-wide beds are too wide, 30" is about the maximum for easy access, though if they're only 3ft long as well, there's access all round.

Two long beds and baskets made more than 50 square foot spaces

We adapted the square foot principle to the space we had, as many do, and ended up with two long adjacent beds and several other smaller ones.

We prefer long beds in general (like the traditional Chinese farmers in the local villages), and this is what we recommend: units consisting of two adjacent beds, each 2ft wide and 8ft long, with a 15"-wide path between and around them. This is enough for two people, or if you want more or there are three of you, make two units with 6ft-long beds instead of 8ft, or two units with 8ft-long beds, and so on. Paths should normally be wider, wide enough for a wheelbarrow, but these beds are short, so save space and use buckets if you need to.

Square foot beds face the sun, so there's a front and a back. At the back there's a trellis for climbers (see below), so if you want to make ranks of units, one behind another, they'll have to be quite far apart to allow the sun to reach the rear ones over the trellises in front. You'll have to figure it out. Otherwise have them in line. Or both. Or scatter them about wherever you can fit

them in.

Trellises

We made a trellis out of an old bamboo ladder and string

Standard square foot trellises at the rear of each unit are a simple hoop made of electrical conduit pipe, two sides and a top, with wires or string running from the top bar to the ground every foot for the plants to cling to (or be tied to).

This is a neat system, but you can use whatever you like, as long as it fills the function. We use bamboo. The standard height is 6ft, but our last tomato crop went up nearly 12ft, and so did the cucumbers, and the beans appreciated as much height as they could get. Higher is better -- if it's needed it'll be there, if not it won't be in the way.

Cement

No ground at all? High-rise living? There's still a lot you can do. You can have a small square foot garden on a balcony, a bigger one on a rooftop. Check the weight considerations for your rooftop, and it might be wise to check the local by-laws. The Rooftop Gardens Resource Group of Toronto can help you with this:
http://www.interlog.com/~rooftop/
Or email David Shephard & Monica Kuhn (rooftop@interlog.com) for a useful information pack.

A square foot unit measuring 16 sq ft and 12 inches deep will weigh somewhere around 300 kg, depending on the soil, the water content, etc.

You can break up a unit any way you like to fit the space available, right down to single one-foot squares, in boxes or baskets or whatever containers you can find. It then merges with **container gardening**.

If you use beds, say two 2x4ft beds with wooden sides, you can just stand them on the cement. If the soil is rich and 12" deep your plants will thrive, and the beds won't leak unless there's a real storm. It might stain the cement underneath, and if that bothers you, try putting them in big wooden trays covered with two thicknesses of heavy-duty plastic.

These miniature green peppers in 9" pots produced heavy crops for months.

Soil

But where will you get the soil? Check the municipality and the agricultural extension office for sources of compost. Better to make your own compost (see **Composting indoors** and **Vermicomposting**), but it will take time to make enough.

Try this mix:

- 8 cubic feet of compost
- 4 cubic feet washed sand
- 4 cubic feet coarse vermiculite
- 2 litres of wood ash
- 0.5 litres gardener's lime or 1 litre ground limestone

Try to include some good topsoil, mainly for the sake of the clay content. You can also use sphagnum **peat moss**, **coconut coir**, perlite, though they're inert and don't contain any nutrients. Sawdust is difficult stuff in garden soil, best avoid it -- especially sawdust from pressure-treated timber, which has poisons in it.

No compost?

If you can't get compost, leaf-mould will do, but it might be short on nutrients -- add a litre of organic fertilizer such as bloodmeal, ground peanut cake, alfalfa meal, ground steamed bonemeal. Fish emulsion is useful -- check the label to see it's all fish and has no chemical fertilizers added.

Liquid seaweed emulsion is one of the best sources of micronutrients and a real soil and plant health booster. Use some in the watering can every two weeks.

Tip:
Spray transplants with seaweed emulsion before you replant them, especially bare-root transplants.

Probably the best fertilizer is diluted urine (1:4 water). It's the mainstay of a successful container farming project in Mexico City: "Regarding fertilizer, considering the expense of commercially prepared fertilizers, the amount needed for a full-size deck garden and the fact that many of them don't work well, I have found that urine is the best fertilizer for this system. The decaying leaf medium breaks it down almost instantly so that there is never any odour, and germ survival in material such as this has been shown to be practically nil. This is a key element in this technology, is abundant, with no cost, and easy to manufacture." -- **Container Farming -- Organic food production in the slums of Mexico City**

Dr Steve Martin's recipe for a soil activator to encourage the growth of the all-important soil microorganisms is a useful fertility booster.
Milly's Bug Juice

Raised Bed Agriculture -- Minifarms Network: "For home gardening raised bed agriculture means: less work, less irrigation, improved soil, higher yields and no poisons. For market gardeners, mini-farmers and mini-ranchers it means all the above plus profits. RBA creates a healthy soil to grow healthy plants to provide healthy food to feed healthy people." 2,200-word article from Ken Hargesheimer in Texas, who has taught organic growing in permanent raised beds worldwide.
http://www.minifarms.com/rba.html

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Milly's Bug Juice

One 5 gallon bucket
Corn starch
Bread yeast
Milly's MaxGro fishmeal (or use fish emulsion plus liquid seaweed emulsion)
Ripe fruit, such as plums, apples, apricots, peaches, pears, watermelon, peeled bananas -- no citrus.

The Bug Juice Formula

Yeast: Mix two teaspoons of dry baker's yeast, two teaspoons of sugar and one teaspoon of bread flour to 2 cups of warm water. Keep warm. It releases CO2, mix the solution to reduce the foam. Keep doing this until the mixture stops foaming. This means the sugar has been consumed. Add two tablespoons of cornstarch, or potato starch, 1 tablespoon of flour (a protein and nutrient source for the yeast) and allow the mixture to remain warm (very important) for 2 or more hours. Overnight is optimal. Then put it in the bucket.

Fruit: Pit the fruit, and puree it to a mush so it can be more rapidly digested by microorganisms. Add 1 pound or so to the bucket. Decaying fruit is fine -- it is already being attacked by microorganisms so it doesn't hurt to include them.

Cornstarch: Add 5 tablespoons to the bucket.

MaxGro: Add 10 tablespoons MaxGro (or fish emulsion plus liquid seaweed emulsion) to the bucket.

Fill the bucket with water to a few inches from the top and mix well. Add a handful of compost or the soil from around the root zone of a nicely growing plant (don't use surface soil). Place the bucket in the sun and put a piece of cheesecloth over it to keep flies away. Stir often. Don't fill the bucket up to the top.

After a week, start applying the mixture to your plants. It is best placed near the roots when transplanting (it prevents transplant shock). Otherwise, pour the Bug Juice into the soil around the plants. After it is absorbed, water extensively in order to get all the bugs and nutrients into the soil. They won't do any good if they remain on the surface. Apply 1 cup to 1 gallon of Bug Juice

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to each plant. Only trees and large plants require 1 gallon.

Dr. Stephen Martin
Milly's Gourmet Organics
Mailing list email: milly@ap.net

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Plant spacings in a Square Foot Garden
http://www.squarefootgardening.com/html/body_PlantSpacing.htm
Spacings for all the common vegetables and herbs, with diagrams: Cabbage: 1 per sq ft, carrots: 16 per sq ft, etc.

Square Foot plant spacings (UK)
http://www.squarefootgardening.org.uk/sqftspacings.htm
More square foot plant spacing information by Organic-UK.

Spacing table

Based on the "Square Foot Gardening" book, plus our experience at the Journey to Forever organic garden.

X

One plant in a square (one foot space between plants)
cabbage, broccoli, cauliflower, pepper, eggplant, okra, tomato

X	X
X	X

Four plants in a square (six inch space between the plants)
lettuce (crisphead, butterhead, loose leaf), Swiss chard (silver beet), bush beans, kai laan tsoi, baak choi, choi sum, komatsuna, Indian mustard

X	X	X
X	X	X
X	X	X

Nine plants in a square (four inch space between the plants)
lettuce (cos, mini), beet root, radish, spinach, een choi (leaf amaranth), garlic,

X	X	X	X
X	X	X	X
X	X	X	X
X	X	X	X

16 plants in a square (three inch space between the plants)
radish, carrot, spring onion, celery,

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-	-	-	-
X	X	X	X
X	X	X	X
-	-	-	-

Special: climbing beans, peas

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No ground? Use containers

Bushbeans in a special square foot basket, light and easy to carry -- ideal for schools with no grounds to start gardening projects.

You can grow plants in virtually anything that holds some soil and has holes in the bottom for drainage. It's only bounded by your imagination -- a chance for some really creative recycling.

We use old bathtubs, 20-litre plastic containers with the tops cut off, baskets of various sizes lined with garbage bags to hold the water in, milk cartons for seedlings, anything that comes to hand. We almost used some dumped toilet bowls, only we didn't like the color (pink).

-- "You can raise a surprising amount of food on your roof, deck, patio or windowsill. The rewards can be large, even if your space is small" -- Chuck Crandall and Barbara Crandall, "Movable Harvests"

Grow a **pillar of vegetables** -- 12 square feet of growing area on only 1.2 sq ft of ground. See **Growing columns**.

Container gardens help to feed the poor in Third World cities -- see **City farms**.

We stuck three sprigs of Creeping Buttercup in a gaily-painted enamel Chinese chamber pot with some holes drilled in the bottom. Now it forms a border round all the growing beds and beyond -- what we call our "lawn". It seems to make its own soil on the cement, catching dust and sand with its hardy roots, it survives trampling and typhoons, and provides a lot of compost material -- and no, it doesn't invade the beds. The chamber pot's still there, discreetly hidden from view behind the granite rock in the foreground -- and by the buttercups.

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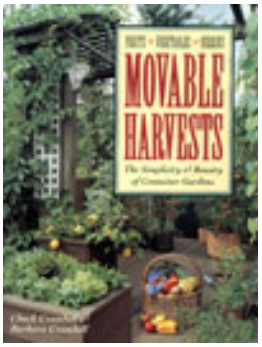

"Movable Harvests -- The Simplicity & Bounty of Container Gardens" by Chuck Crandall & Barbara Crandall, Chapters, Vermont, 1995, ISBN 1-881527-70-0, $19.95. Anything that grows in a conventional garden can be grown in a container -- even asparagus, pumpkins, corn, and apples, apricots, peaches, pears, figs, and bananas. The authors -- seasoned "bucket gardeners" -- grow 90% of their produce in a variety of containers. Lots of useful advice from the experts.
From ECHO's global bookstore:
http://echonet.org/shopsite_sc/store/html/MovableHarvests.html
From Chapters:
http://www.chapters.ca/books/

"Gardening in Containers" by Robert J. Beckstrom and Michael D. Smith, 1996 "Everyone, everywhere, even urban apartment and condominium dwellers, can have a green space to call their own." How to select flowers, fruits, vegetables, vines, shrubs, and trees -- extensive plant encyclopaedia provides detailed growing instructions for more than 150 plants suited to container gardening. Design guidelines for a practical, attractive garden for whatever space you may have. Choosing containers, transplanting, soil mixes, watering, and fertilizing. From ECHO's global bookstore:
http://echonet.org/shopsite_sc/store/html/GardeningContainers.html

"Above-Ground Gardens" by Dr. Martin L. Price & Laura S. Meitzner, 1996, ECHO Technical Note (reprinted from Ch 17 of ECHO's book Amaranth to Zai Holes, 1996), Educational Concerns for Hunger Organization (ECHO)

Urban food production is often overlooked by development planners. There is considerable potential to involve millions of city families in food production, who may not at first seem to have anywhere to garden -- where there is plenty of sunshine but either no soil or the soil does not lend itself to cultivation. ECHO and others have developed "above-ground" techniques suited for such sites: the countless hectares of sturdy, flat cement rooftops and many more hectares of tin roofs on insubstantial shanties, steep hillsides, extremely poor soils, yards of rock or cement, spaces around tree roots, and places where land tenure is so unstable that

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Urban farming in Haiti -- AGUILA Urban Agriculture Research Network Latin America
http://www.idrc.ca/cfp/aguila.html

only portable gardens are attractive. ECHO has been working on methods for gardening in such situations since 1982. Online (Acrobat file):
http://www.echonet.org/tr
Full-length version, in Amaranth to Zai Holes:
http://www.echonet.org/tr

Windowbox.com -- all the information and supplies you need to grow flowers, vegetables, and herbs in any container on your porch, deck, terrace, patio, or windowsill. Good resources and advice, expert-system answers plant questions, site search.
http://www.windowbox.com/

Harvesting sweet potatoes from a bathtub

GardenGuides' Container Gardening Guide Sheets are a useful source of instant information: 21 different guides. The two-page basic Guide to Container Gardening covers Choosing containers, Growing mixture, Sunlight, Fertilizer, Watering, What to grow? on the first page, while the second page deals with vegetables: common vegetables listed with type of container and recommended variety, linked to references on each vegetable covering types, conditions, maintenance and harvest, pests, recipes and useful links. The website has hundreds of other guides on all aspects of gardening, and further resources. Guide to Container Gardening:
http://www.gardenguides.com/TipsandTechniques/container.htm
Guide to Container Gardening (Page 2):
http://www.gardenguides.com/TipsandTechniques/container2.htm

The **Rooftop Gardens Resource Group of Toronto** has a good set of resources on gardening in the air -- without collapsing your roof with too much heavy soil! Resources on roofing, structural considerations and building codes. "It is the strong belief of this group that rooftop gardens represent an opportunity to greatly enhance the urban landscape, offering a richer lifestyle which balances environment health and integrity with the vitality of

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the city."
http://www.interlog.com/~rooftop/

Pumpkins happily growing on the roof of the Beach House kitchen

"The Green Roof Monitor" reports on greening the rooftops of city buildings in Toronto, Chicago, and European cities. In Germany, 10% of all flat roofs have gardens -- over 55 million square metres of green roof infrastructure in place since 1989. Almost 50% of German cities (77 cities) have programs in place that support the development and growth of a market for green roof infrastructure. In Chicago, the city environment department plans to plant gardens atop several city buildings as part of a US Environmental Protection Agency program studying ways to help cool cities and reduce smog. The Green Roof Monitor is published by City Farmer, Canada's Office of Urban Agriculture, available online.
http://www.cityfarmer.org/GreenRoof.html#greenroof

Rooftop Gardening (Video) -- A one-tape presentation on rooftop gardening. Interesting and fun ways to grow food in urban areas and small spaces, plants and techniques for above-ground gardening, learn about tire gardens and gutter gardens, see how to grow food with no soil. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/page104.html

Container Farming -- Organic food production in the slums of Mexico City. Fifteen million Mexicans live in extreme poverty -- above all in urban marginal areas like the slums of Mexico City. Some seven years ago a group of NGOs launched a project to help people there to grow their own food organically in small backyards or patios, balconies, roof tops -- as a way to help counteract the poverty being imposed upon them. This is the report on the project, by sociologist and community worker Rodrigo A. Medellín Erdmann.

Fokke van Katwijk's **Toyota Corolla garden** in Amsterdam
Mobile harvests: guidelines and instructions on turning your car into a garden, from Amsterdam's Private car & garden site -- they call it "creative conversion of parking places".
http://huizen.dds.nl/~autotuin/

autogarten.html

Urban Garden -- a 12-month journal of a container garden in in the heart of Vancouver. "There are more than 70 containers, completely surrounded by city, with a tiny view of the ocean." With details of plants, plus chores, and hints. Three-year views for each month, resources and links. Award-winning site -- simple, elegant, useful. Fine photographs.
http://www.urbangarden.com/

Container gardener Keith Moss of Florida likes to take his garden with him

Container Gardening forum at Garden Web -- active forum for online discussion, search function.
http://www.gardenweb.com/forums/contain/

Vegetable Seed Varieties for Containers -- Suite101.com. A lot more seed companies are selling vegetable seeds specially bred to meet the small-space needs of container gardening. Here's a useful list of varieties, eg: "Cucumber 'Salad Bush' (56 days) -- 22 inch vine, full sized slicing cucumbers."
http://www.suite101.com/article.cfm/container_gardening/32565

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Midori carrying a one square foot basket with nine cos lettuces

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Container Farming

Organic food production in the slums of Mexico City

by Rodrigo A. Medellín Erdmann

By the middle of the 1990s, forty million Mexicans -- nearly half the total population -- fell below the poverty line. And of these at least 15 million live in extreme poverty -- above all in urban marginal areas like the slums of Mexico City. Some seven years ago ANADEGES, a group of some 20 autonomous NGOs, launched a project to help the people there to develop their own autonomous capacity to produce food organically in small backyards or patios, balconies, rooftops -- as a way to partially counteract the poverty being imposed upon them.

The technology had to address four constraints: little or no land, little or no investment in infrastructure, no purchase of chemical inputs, and be light weight for rooftop cultivation.

Three years were spent in a quasi-experimental stage. It is important to point out that these experiments were actually a trial and error process by an amateur with no agronomic training. An expert would have probably taken a much shorter time. On the other hand, an expert agronomist would probably not have dared to experiment with such lowly technology. During the last four years, the project has been introduced to several hundred families in six different slum areas of the city.

The starting point was a cultivation technology developed by Dr. Barbara Daniels in California, USA, in a nutshell: vegetables are grown in drainless containers ideally with 18 to 20 liters capacity -- stuffed with deciduous tree leaves or grass clippings up to 4/5ths of their capacity, topped by a three to five centimeter layer of good soil, where seeds are planted, or seedlings are transplanted. On the wall of the container, five to ten centimeters from the bottom, a hole is bored for drainage the container thus maintains a water reservoir at the bottom. Finally, a stick is inserted right down to the bottom, that is used to measure the containers' humidity as you would the oil in a car. A container thus prepared, weighs far less than one filled with regular soil.

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The best organic fertilizer: urine

The key to this technology is fertilization. While chemical fertilizers can be used, Dr.Daniels suggests a much better alternative: an organic, domestically produced, high-power fertilizer. Regarding fertilizer, considering the expense of commercially prepared fertilizers, the amount needed for a full-size deck garden and the fact that many of them don't work well, I have found that urine is the best fertilizer for this system. The decaying leaf medium breaks it down almost instantly so that there is never any odor, and germ survival in material such as this has been shown to be practically nil. We call this liquid organic fertilizer (LOF).

The LOF, a key element in this technology, is abundant, with no cost, and easy to manufacture.

For several years the aim was to obtain empirical results in terms of low cost organic production of vegetables. During this time no thought was given to scientific experimentation. Consequently the results were gradually observed and understood in a merely empirical fashion, with little quantified data. We arrived at five main findings:

1. Plants grew more rapidly, bigger and healthier than those grown with conventional agricultural techniques. Less water was needed.
2. In the case of plants that produce edible leaves -- lettuce, spinach, Swiss chard, chives, parsley, quintoniles (*Amaranthus hybridus*), quelites (*Chenoponium album*), verdolagas (*Portulaca oleracea*) and all types of herbs -- the produce was outstanding. Leaves were big and bright dark green in color. Particularly remarkable was the nopal (*Opuntia* sp.), a cactus with big, green, prickly, pallet-like edible leaves, actually transformed stems, tender and fleshy (*pencas* in Spanish) very much appreciated in Mexico. It has excellent nutritious value: it has been called the Aztec beefsteak and serves as a natural medicine, for example, for diabetes.
3. Some fruit-bearing plants, specially hot peppers essential in the Mexican diet, grew well and produced abundantly; but were not as hot as those conventionally grown.
4. Other fruit-bearing plants did beautifully in their early stages, but rather poorly in terms of fruits. Such was the case of tomatoes, green tomatoes (*Physalis pubescens*), squash, beans, cauliflower, cucumber.
5. Some experimentation was made with root plants, but not

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much, since the containers being used had a relatively small diameter, and could accommodate too few plants. There were good results with radishes. However, people would certainly be interested in onion and garlic. Carrots are usually so inexpensive in the market, it is not cost effective to cultivate them.

Other intriguing features: all plants did particularly well in their early stages; they proved remarkably resistant to insects, pests and diseases.

A warm bed for the plants

The next stage was to understand these first results, and to look for ways of improving them. In short:

LOF was an excellent source of nitrogen (N), readily absorbable by the plant. This was why the leaves did so well. In this technology there was a deficiency of phosphorus (P) and potassium (K); no idea about minor nutrients. The initial process inside the container was a very intensive anaerobic composting, which raises temperatures; this acted as a warm bed that helped plants in their early growing stages.

More puzzling was the resistance of plants to pests and diseases. In one instance, a set of tomato plants was growing near a tree heavily infested with the white fly. Many of these insects would fly around the plants ordinarily so prone to being attacked by them but not one landed on the leaves. They simply flew back to the tree. Eventually, an article in a German scientific journal gave us the clue. The composting process taking place inside the container produced substances that helped the plants become not only stronger, but also resistant to pests. An added bonus.

At the end of a year, the composted leaves had turned into a beautiful, rich soil. Each container produced enough soil to supply the top five centimeter layer in ten new containers, or for any other use.

If the technology was to be really useful to people, the missing elements had to be found. What was needed was a cheap, abundant, readily available, organic source of P and K, like we already had of N. Furthermore, these two major nutrients had to be immediately absorbable by plants, since their life cycle was so short: three or four months. It was not the case of some organic matter that could be mixed with soil to be decomposed over several months or years.

As is usually the case, the solution was found by chance, to a certain extent. For other reasons Anadeges began to experiment with worm raising, the type of red worms that process organic waste (*Eisenia foetida*). Eventually we realized their castings were exactly what we were looking for. They contain the P and K the plants need, readily absorbable, and can be produced abundantly and at no cost by the families themselves. Between LOF, worm castings and decaying leaves, plants also have enough minor nutrients. An additional environmental bonus: kitchen refuse could be recycled, instead of thrown into the garbage.

The aim of the project was to benefit families. Consequently, it was proposed to them once results were sufficiently satisfactory, without waiting for perfection. The lack of organic P and K was temporarily supplied with chemical fertilizers. It was important to check up on their acceptance, especially of LOF. In the last four years, the project was implemented among several hundred families in six slum areas of Mexico City.

For this stage, the project received partial financial support from GATE-ISAT in Germany and the St. Nikolaus Foundation in Sweden. A Mexican chain of supermarkets agreed to give the project all their used containers (we had to collect them and clean them), which was a great boost. We tried, but could not get any support from local Mexican government agencies at that time.

The project lessons

LOF was easily accepted, even though it was a conclusion reached through a quasi-maieutic dialogue: "We can make an agreement with mother earth, to give her what we no longer need, and ask her to provide us with what we need. What is it that we no longer need? etc"; along with a medical explanation confirming that urine is a clean and pure substance, and properly fermented is harmless.

To be constant in the care of a vegetable garden specially to overcome the difficulties in the early stages -- people need to have more than one of the following motivations, amongst others:

- availability of food to improve nutrition
- economic savings
- a nice hobby for the whole family
- healthier, fresher organic food
- recuperation of agricultural skills -- most elders come from rural communities
- closer contact with nature
- increased political independence from government

assistance
- ecological concerns: recycling of garbage
- container plants as house ornaments
- relaxation from urban stress
- friendship and meetings with other women raising plants.

People were willing to pay a price equivalent to costs for the implementing agency. In turn, during the first year families should harvest produce at least equivalent to the price they paid. This would eventually make the project self-financing.

It was mostly women that were interested in container vegetable gardening. And it is always a community activity. Besides food plants, women from slum areas began to request ornamental flowers and trees. We readily complied.

It is important to work in an organized context, so the implementing agency does not need to bear the burden of organizing people.

There should be relative tranquillity in the community, for people to dedicate enough time to their gardens. If there is political or other kind of unrest, people tend to be distracted and disregard their plants.

Conclusions

Further experimentation with the more complete fertilization system is necessary. In this context, soil pH is a variable that has to be better understood. We also plan more experimentation with wormfeed to include substances that could increase the percentage of P and K in the castings.

The project will expand to many more families and slum areas. At this stage some form of government support is likely, to open new areas, and to tackle other aspects of the project such as:

- Utilization of discarded tires turned inside out, to be used as wide-mouth containers with greater capacity, excellent for root plants. This would also address a staggering ecological problem in a city like Mexico with literally mountains of used tires.
- A shift from an artisan to an industrial production system with several production lines: plants, containers, worms, tires.
- A drive to reach the financial break-even point, and achieve self-financing for the whole operation.

- Start experimenting with backyard animals.

The project has been successful in perfecting a technology to cultivate vegetables in containers organically, with no industrial external inputs - by utilizing readily available, zero-cost waste matter and discarded containers. It is a sustainable urban agriculture system easy to expand, that can help people recover their autonomous capacity to reach a certain degree of self-sufficiency in food production. But much more needs to be done.

Notes

Barbara Daniels, Growing Plants in Containers: new guidelines for a deck garden. Multicopied. Fairfax, Ca., 1981. On several occasions the project tried to get in touch with Dr. Daniels, but could never locate her.

Tränkner, Andreas, Kompostextrakte kontra Schadenpilze, in Garten Organisch, 4/1990, pp. 13-15.

Rodrigo A. Medellín Erdmann is a sociologist who has been working with campesino and Indian communities and organizations in Mexico since 1974. He is a co-worker of ANADEGES -- "Autonomy, Decentralization and Self-management" -- created in 1982. One of the institutions of the group, Cedicar, manages the project described here.

ANADEGES -- Autonomía, Descentralismo y Gestión -- Socios Técnicos
http://www.bioplaneta.com/espanol/socios_tecnicos/anadeges.html

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When to sow what

When to sow what

"Things to do in the garden now" from HDRA -- the organic association. Month-by-month online organic gardening calender for temperate regions (UK), detailed, well-organized, down-to-earth guidance from the experts. Well illustrated.
http://www.hdra.org.uk/todo_now.htm

"Vegetable Garden Year" -- month-by-month calendar for British growers, information from "The Vegetable Garden Year" by Daphne Ledward.
http://www.organicgarden.org.uk/growing/grow/vegyr.htm

The Territorial Seed Company has Planting Charts for the USA. A useful Seed Usage and Yield chart shows how many seeds to sow per 100' row, per acre, distance between seeds, thin plants to..., distance between rows, depth of seed, when to plant, days to maturity, yield per 100' row, for all the vegetables.
http://www.territorial-seed.com/links/charts/links_charts.html

The 2001 US National Arboretum "Web Version" of the US Department of Agriculture Plant Hardiness Zone Map -- click on any area to go to a close-up, or click on your State abbreviation below to go to that region.
http://www.usna.usda.gov/Hardzone/

The American Horticultural Society's Heat Zone Map -- this Zip Code Zone Finder will tell you the Heat Zone rating for your specific area.
http://www.ahs.org/publications/zipfinder.htm

Plant Hardiness Zones of Canada 2000
http://map1.agr.ca/scripts/esrimap.dll?name=Plant2000&Cmd=Map&Lang=En

Plant Hardiness Zones of Europe
http://www.marblenet.es/pjse/mapuse.htm

Seasonal vegetable planting guides for the Southern Hemisphere: Summer, Spring, Autumn, Winter -- from the Canberra Organic Growers Society (COGS). With other useful articles from Canberra Organic Quarterly Magazine and other

Sowing times for different regions
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COGS brochures.
http://www.cogs.asn.au/methods.html

Seed sowing and harvesting times for Hong Kong (from "Vegetable Cultivation in Hong Kong" by G.A.C. Herklots, Hong Kong, 1941)

Vegetable Garden Calendar for Hong Kong

From "Gardening for Hong Kong", by W.J. Tutcher, F.L.S., Superintendent of the Botanical and Forestry Dept., Hong Kong, formerly of the Royal Gardens, Kew, 1913.

JANUARY

- Seeds of the following may be sown: Mustard and Cress, Radish, Turnip, Chinese Spinach, French Beans, Peas, Cucumber, Lettuce, Tomato, Vegetable Marrow, Sweet Corn and Chinese Long Beans.
- Plant out young plants of the following: Cabbage, Lettuce, Endive, Kohl Rabi and Brinjal.
- Earth up Celery as required, previous to which give the beds a good watering.
- Tie up Cos Lettuce to blanch them, and put flower pots over Endive for the same purpose.
- Put in cuttings of Tomatoes, as plants raised in this way fruit earlier than those from seed.
- Fresh beds of Watercress may be made.

FEBRUARY

- Seeds of the following may be sown: Mustard and Cress, Radish, Turnip, Chinese Spinach, French Beans, Peas, Cucumber, Lettuce, Sweet Corn, Chinese Long Beans, Water Spinach, Ochroes and Sword Beans.
- Put out young plants of the following: Lettuce, Vegetable Marrow, Tomato, Cucumber and Brinjal.
- Towards the end of the month Jerusalem Artichokes may be planted.
- Asparagus beds may now be manured.
- Lettuce and Endive blanch for succession.
- Earth up Celery for succession.

MARCH

- Seeds of the following may be sown: Mustard and Cress,

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Radish, Turnip, Chinese Spinach, French Beans, Cucumber, Lettuce, Sweet Corn, Chinese Long Bean and Ochroes.

- Plant out any seedlings ready from last month's sowings.
- Canavalias (Sword Bean) should be planted
- Watercress may still be planted.
- Plant out Tomatoes raised from cuttings.
- Brinjals may be planted.
- Get stakes ready for Cucumbers, Canavalias (Sword Bean) and Chinese Long Beans.
- Jerusalem Artichokes may still be planted.

APRIL

- Seeds of the following may be sown: Mustard and Cress, Chinese Spinach, French Beans, Cucumber, Lettuce, Sweet Corn, Chinese Long Beans, Ockro and Brinjal.
- Plant out seedlings (raised last month) of Cucumber, Lettuce and Ockroes.
- Stake Canavalias, Cucumbers and Long Beans as they require it.
- Keep the surface of the beds in good condition with the Dutch hoe. Plants cannot thrive with a hard, baked surface to the soil.

MAY

- Seeds of the following may be sown: Mustard and Cress, Chinese Spinach, French Beans, Cucumber, Lettuce, Sweet Corn and Chinese Long Beans.
- Put out last month's seedlings of Cucumber, Lettuce, Ockro and Brinjal.
- Seedlings of Chinese Spinach may be planted out if desired, but if frequent sowings are made this is not necessary as seedlings pulled from the seed-bed are more tender than those which have been transplanted.
- Attend to the staking of Cucumbers and Long Beans.

JUNE

- Seeds of the following may be sown: Mustard and Cress, Chinese Spinach, Cucumber, Lettuce, Sweet Corn, Chinese Long and Short Beans, Chinese Green and White Cabbage.
- Thin out some of the leaves of Chinese Long Beans.
- Brinjals will be better if they have some of their leaves

Education resources on the Web
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taken off, as they will continue to bear much longer, especially if they are given a little more manure at the roots.

JULY

- Seeds of the following may be sown: Mustard and Cress, Chinese Spinach, Cucumber, Lettuce, Sweet Corn, Chinese Short Beans, Celery, ~Chinese White and Green Cabbage.

AUGUST

- Short Beans sown last month will require staking. Seeds of the following may be sown: Mustard and Cress, Chinese Spinach, Lettuce, Sweet Corn, Chinese Green and White Cabbage, Celery, Tomatoes and Carrots.
- Dig over all vacant ground, so that it will be in good condition for sowing seeds in September and October.

SEPTEMBER

- Seeds of the following may be sown: Mustard and Cress, Chinese Spinach, Lettuce, Sweet Corn, Chinese Green and White Cabbage, Radish, Beet, Carrot, Cabbage, Cauliflower, Vegetable Marrow and Celery.
- Plant out Tomatoes.
- Transplant Celery from seed pans into nurse beds.
- Towards the end of the month manure the beds for the bulk of the winter crops.
- Obtain Brinjal seeds for sowing next month.

OCTOBER

- Seeds of the following may be sown: Mustard and Cress, Lettuce, Chinese Green and White Cabbage, Radish, Beet, Carrot, Cabbage, Cauliflower, Celery, Brussels Sprout, Endive, Prickly Spinach, Turnip, Parsnip, Salsify, Pea, French Bean, Thyme, Sage Marjoram, Parsley, Brinjal, Chillies, Asparagus, Leek, Savoy Cabbage and Kohl Rabi.
- Plant out Cabbage, Cauliflower, Vegetable Marrow and Celery.
- Potatoes may be planted about the middle of the month.
- Procure seeds of Ockroes, Water Spinach and Chinese Spinach.

NOVEMBER

- The same kinds of seeds as last month may be sown either for succession or to replace failures.

- Plant Celery, Potatoes, Cabbage, Cauliflower, Brussels Sprouts, Lettuce, Endive, Kohl Rabi &c.
- Earth up first bed of Celery, also of Potatoes.
- Tie up Lettuce to blanch them. Lettuce plants through the summer will never be big enough to tie up, but with cooler weather the plants will be bigger and this may be done.

DECEMBER

- Seeds of the following may be sown: Mustard and Cress, Lettuce, Radish, Cabbage, Celery, Turnip, Peas and French Beans.
- Plant out seedlings of Celery, Cabbage, Cauliflower, Lettuce, &c.
- Earth up Celery and Potatoes.
- Keep the soil well stirred in the beds and see that everything is watered sufficiently.

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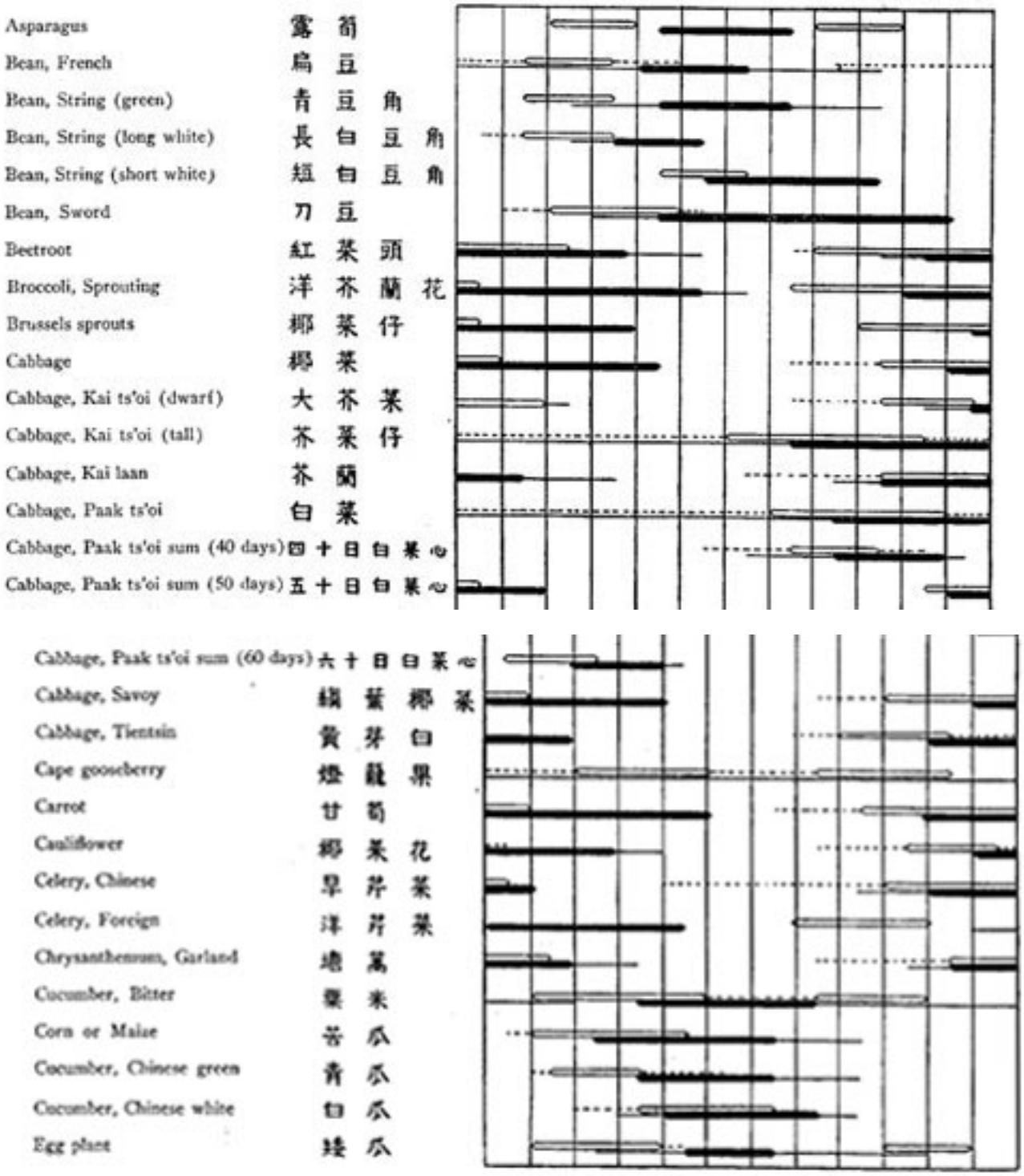
Hong Kong cropping calendar

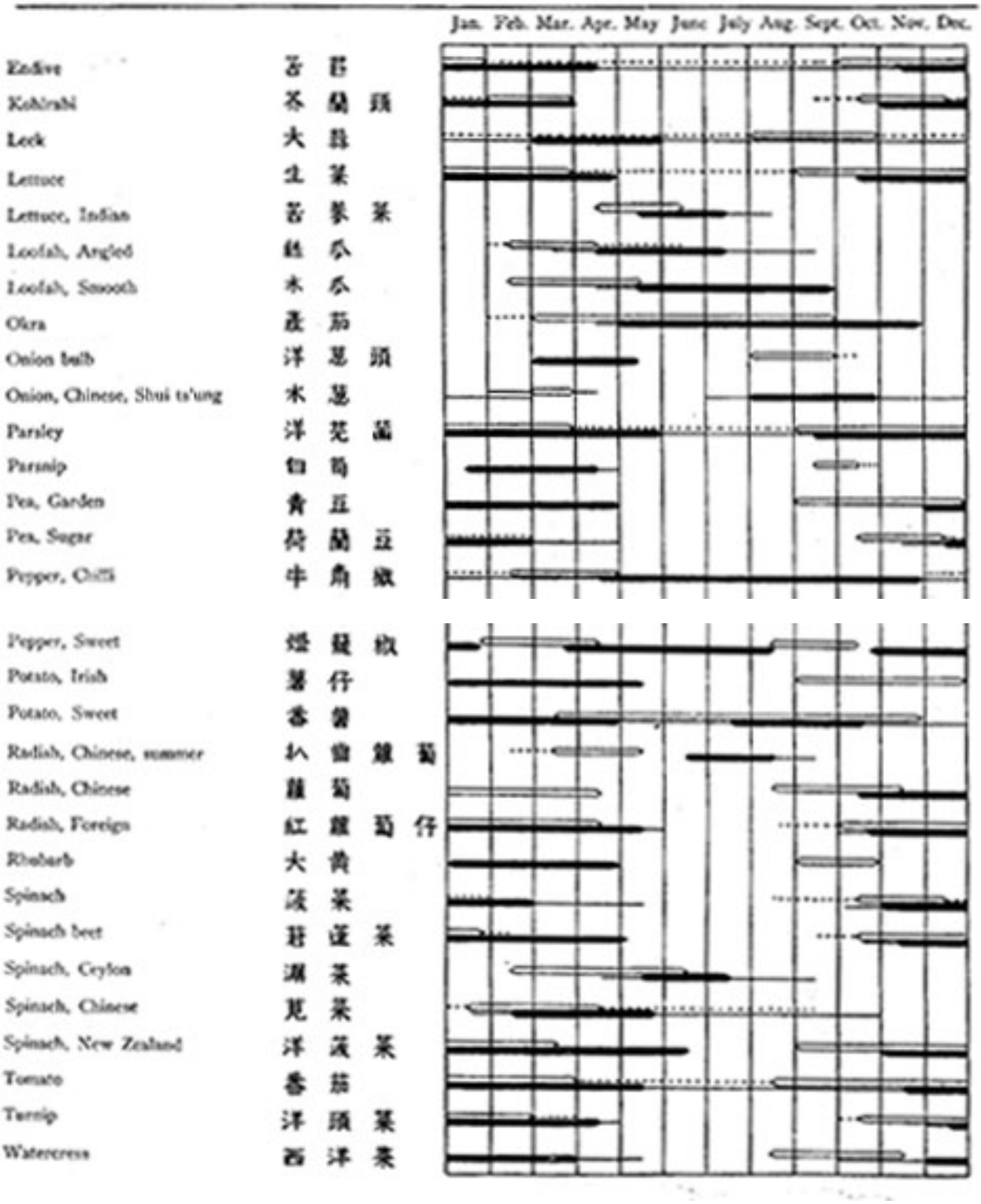
From "Vegetable Cultivation in Hong Kong", Geoffrey Herklots, 1941

CALENDAR

SEED-SOWING AND HARVESTING

Seed-sowing times shewn in white, times when crops available shewn in black.





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Garden pond

Seeds

See **Seeds of the world** for resources on seed saving and heritage seeds.

Cyndi's Catalog of Garden Catalogs, one stop for all the mail-order gardening catalogs in the US and Canada -- over 1,900 of them! Check here first to find the company and see its ratings for quality, service, price and breadth of varieties. Links to other gardening sites and mail-order companies outside North America.
http://www.qnet.com/~johnsonj/

ICanGarden online database of gardening catalogs, search by province/state (US and Canada), by country, by keyword or by category -- everything from Alpines to Worms. Also a bookshop, online gardening forums, newsletters and more:
http://www.icangarden.com/catalogue.cfm

The Organic Gardening Catalogue from Britain's **HDRA** -- the organic association, free copy sent by mail, order it online.
http://www.hdra.org.uk/catalog.htm
Buy direct online:
http://www.organiccatalog.com/cgi-bin/index.cgi

Johnny's Selected Seeds have their own certified organic trial and research farm in Maine for seed production and to grow, breed, and evaluate over 4,000 new and experimental varieties each year. Catalog has 1,200 items. Vegetables, medicinal and culinary herbs, flowers,
http://www.johnnyseeds.com/

Territorial Seed Company -- good variety of vegetables and herb seeds, flowers, mixes, grasses, cover crops, transplants and jump-starts, large selection of gardening supplies. Secure interactive online catalog. Also useful Planting Charts.
http://www.territorial-seed.com/

Seeds of Change: Certified Organic Seeds, Bulbs and Food -- founded in 1987 to foster plant life and bio-diversity. Offers certified organic, open-pollinated seeds to the public (no GMOs!). A favourite with organic growers. Online seed catalog with over 1,500 different seed varieties including many Heirloom, Traditional, Medicinal and Original seed varieties. Garden tools, books. (US and Canada only.)
http://www.seedsofchange.com/

seedman.com -- Seeds from Around the World. SBE is a family owned and operated seed business serving home gardeners, university botanical departments and research facilities worldwide. Thousands of seed listings on this site, loads of categories, and its own search engine. Seed site with depth: Heirloom/Open Pollinated Vegetable Seeds sealed in poly bags with two year guaranteed shelf

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life, Seeds for a Bee and Butterfly Garden, Seeds for a Bible Garden, Chinese/Japanese/Korean Stir-fry Vegetables, Seeds for Chinese Medicinal Plants, Seeds for a Herbal Tea Garden, Medicinal Herbs and Healing Plants, Ornamental Grass seeds from around the world -- it goes on and on and on. Also tree seeds.
http://www.seedman.com/

Heirloom Seeds -- California Grown Certified Organic Seeds
http://www.heirloomseeds.com/organic.html

ATTRA lists suppliers of organic, non-genetically engineered, and heirloom (open-pollinated) vegetable, flower, and other seeds in the US and Canada.
http://www.attra.org/attra-pub/altseed.html

The **organicXseeds** database by Organic Europe lists organic seed and transplants supplied by seed companies from all over Europe, guaranteed free of genetic engineering, plants adapted to organic farming conditions.
http://www.organicxseeds.com/index.htm

Hong Kong seeds
There are three seed shops in Connaught Road, just west of Sheung Wan MTR exit -- keep walking west past the refurbished Western Market and you'll find them.

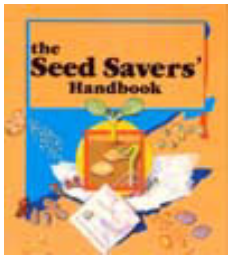
Herbs

Mint in a basket

Richters Herbs -- Medicinal, Culinary, Aromatic -- plants and seeds, organic seeds, online catalogue. This is a great website, packed with information on the wonderful subject of herbs. Also publishes Richters HerbLetter, sent to you by email, a real treasurehouse, top of its class by far.
http://www.richters.com/

Herbin' Center Greenhouse and Nursery -- Herbs: Medicinal, Culinary, and Aromatic, custom growing, wholesale and retail. A-Z online herb catalog, printable Seed Record, Plan a tea garden, articles, herb books.
http://users.townsqr.com/herbin/index.htm

Books



"Seed Savers' Handbook" by Michel & Jude Fanton, 1993
Without dedicated seed savers, our staple foods would not exist. Such seed resources are only safe in the hands of people who save and grow them and eat their bounty; they are lost in "collections" or storage, or in hybrids wholly

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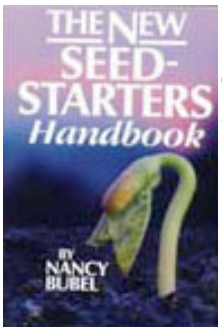
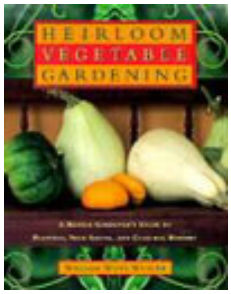
owned by multinationals. The Fantons, founders of Australia's SeedSaver's Network, show how gardeners can protect our global food heritage -- and eat it too. They describe the seed collecting, growth cycles, propagation, cultivation and traditional kitchen and medicinal uses of over one hundred vegetables, culinary herbs and edible flowers. "This book will be of immense use to all of us who grow or want to grow good food in our gardens and on our farms. I believe this book to be essential for all caring gardeners, farmers, cooks and parents and I trust that it will speed our return to good nutrition and a healthy society." -- Bill Mollison (The Permaculture Institute). From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/SeedSaversHandbook.html



"New Seed-Starters Handbook" by Nancy Bubel, 1988, Rodale Press, ISBN 0-87857-752-1
Turn to this book for the most complete, up-to-date information on starting plants from seed. Written by a gardener with 30 years of experience, this easy-to-use reference explains everything you need to know to start seeds and raise healthy seedlings successfully. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/SeedStarterHandbook.html

More good resources on seeds and seed saving from ECHO:
http://echonet.org/shopsite_sc/store/html/Seedsaving.html



"Heirloom Vegetable Gardening -- A Master Gardener's Guide to Planting, Seed Saving, and Cultural History" by William Woys Weaver, 1997, Henry Holt & Company, ISBN 0805040250
Lists 280 varieties of vegetables, all organically grown by Weaver. He has researched the traditional kitchen garden over the course of 30 years. Old fashioned recipes, research on the introduction of these vegetables, color photographs and line drawings. Weaver maintains his own collection of over 2,000 varieties of vegetables, herbs and flowers. From Powell's Books
http://www.powells.com/cgi-bin/biblio?inkey=6-0805040250-3

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Garden pond

The garden pond at our headquarters at the Beach House on Lantau Island is a bathtub propped on bricks, containing water hyacinth, duckweed, frogs, tadpoles, a small and elegant water snake, and no mosquitoes. The tadpoles eat the mosquitoes, the snake eats the tadpoles.

The Journey to Forever garden pond-in-a-bathtub

All we put in it at first was a couple of water hyacinths from a nearby paddyfield, which came with some duckweed. The tub quickly turned itself a balanced environment. The frogs moved in on their own. We've no idea where the watersnake came from.

Sometimes we aerate it a bit with a small goldfish tank aerator, and we throw a handful of compost in it every month or so. It provides a lot of rich pondweed for the compost pile.

Garden ponds can be really beautiful, adding a sense of peace to a garden like nothing else can do. Others can provide you with a lot of food. (See also **Small farms, Aquaculture**.)

Pond resources

Water Gardening magazine for water gardeners and pond keepers. Current and back issues online, index of past articles, tips & faqs, sources of supplies, pond clubs, discussion forum, pond gallery. http://www.watergardening.com/

Pondscapes magazine from the US National Pond Society. Practical information on building and managing a pond, large online collection of

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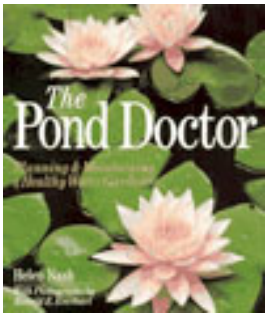
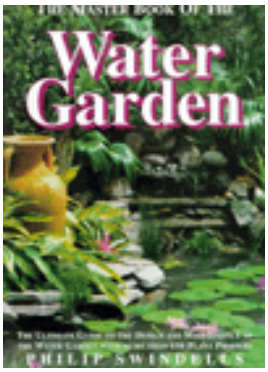
pond information, with more than 700 web pages on designing, building and caring for water gardens, koi ponds, bog ponds, wildlife habitats, wetlands, waterfalls, streams, fountains.
http://www.pondscapes.com/

Water Gardens -- informative 1,600-word article by gardening writer and
instructor Neil Moran at GardenGuides.
http://www.gardenguides.com/articles/watergardens.htm

The **Lure of the Back Yard Pool** -- article by Garden Lady Duane Plummer for GardenGuides.
http://www.gardenguides.com/articles/pool.htm



"Pond Doctor: Planning & Maintaining a Healthy Water Garden" by Helen Nash, Ronald E. Everhart (photographer), 1997, Sterling Publications, ISBN 0806906871
Thorough and well-presented guide: selecting a site, construction, building a waterfall, safety and water-quality tips, pumps and filtration, prevention of algae, caring for water plants and fish. Sees ducks and geese as pests, as indeed they are for a look-at pond. For beginners and everyone else too. From Locust Ridge Water Gardens:
http://lrwatergardens.safeshopper.com/12/10.htm?9
From PETsMART.com:
http://www.petsmart.com/fish/shopping/books__magazines___videos/products/product_15893.shtml



"The Master Book of the Water Garden: The Ultimate Guide to the Design and Maintenance of the Water Garden With More Than 190 Plant Profiles" by Philip Swindells, 1997, Tetra, ISBN 1564651886
Comprehensive guide, detailed step-by-step illustrated instructions on all aspects of water garden construction and maintenance -- ponds, plants and everything else.

"Small Scale Aquaculture: A Guide to Backyard Fish Farming" by Steven D. Van Gorder, 1992, Rodale Institute, ISBN 0-9677732-0-2
Details and plans on how to raise, harvest, prepare, and store over 100lbs of fish in five months. This system is the result of

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eight years of research at the Rodale Research Center. A simple and efficient way to produce your own fish on a scale appropriate for a self-sustaining household. Makes home aquaculture as practical as gardening for providing healthy food for a family. Features an ecologically sound recirculating system designed for low energy and low water use made from readily available materials. From Rodale Institute Bookstore: http://rodaleinstitute.org/bookstore/products/farm_books/3.html

The **FishBase Global Information System on Fishes** was developed at the International Center for Living Aquatic Resources Management (ICLARM) in collaboration with the FAO. Web-based searchable information and pictures on over 20,000 fresh and saltwater fish. Common name, scientific name, location, biology, culture, references, more (25,630 species, 72,000 synonyms, 114,000 common names, 29,000 pictures, 24,000 references). http://www.fishbase.org/

The Journey to Forever garden pond (Keith Addison)

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"An Agricultural Testament" by Sir Albert Howard, Oxford University Press, 1940.
This is the book that started the organic farming and gardening revolution, the result of Howard's 25 years of research at Indore in India. The essence of organics is brilliantly encapsulated in the Introduction, which begins: "The maintenance of the fertility of the soil is the first condition of any permanent system of agriculture." Read on! Full explanation of the Indore composting process and its application. Excellent on the relationship between soil, food and health. Full text online at the Journey to Forever **Small Farms Library**.

"Farming and Gardening for Health or Disease (The Soil and Health)" by Sir Albert Howard, Faber and Faber, London, 1945, Devin-Adair 1947, Schocken 1972
This is Howard's follow-up to An Agricultural Testament, extending its themes and serving as a guide to the new organic farming movement as it unfolded -- and encountered opposition from the chemical farming lobby and the type of agricultural scientists Howard referred to as "laboratory hermits". Together, the two books provide a clear understanding of what health is and how it works. Full text online at the Soil and Health Library: http://www.soilandhealth.org/

"The Waste Products of Agriculture -- Their Utilization as Humus" by Sir Albert Howard and Yeshwant D. Wad, Oxford University Press, London, 1931
Where Howard's famous An Agricultural Testament charts a new path for sustainable agriculture, founding the organic movement at one stroke, this first book is more a practical guide to making compost: how the Indore composting system which was at the foundation of the new movement was developed, and why. Full text online at the Soil and Health Library: http://www.soilandhealth.org/

"Sir Albert Howard In India" by Louise E. Howard, Faber and Faber, London, 1953, Rodale 1954
Albert and Gabrielle Howard worked as fellow plant scientists and fellow Imperial Economic Botanists to the Government of India for 25 years, and this is a study of their work by Sir Albert's second wife Louise (sister of Gabrielle, who died in 1930). It's a classic study of effective Third World development work. Initially involved with improving crop varieties, the pair soon concluded it was futile to fiddle with seeds unless the work took full acount of the system and circumstances as a whole. Thus developed a sustained interest in putting agricultural research into its right relation with the needs of the people, and a fundamental belief in peasant wisdom. Results were useful only if they could be translated into peasant practise. This led to the development of the famous Indore system of composting organic wastes: improved seeds were no use in impoverished soils. It's a great story. Full text

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online at the Soil and Health Library:
http://www.soilandhealth.org/

"The Earth's Green Carpet" by Louise E. Howard, 1947, Faber & Faber, London
In this unusually clear book, Lady Howard (the wife of Sir Albert Howard, founder of the organic movement), has written a "layman's introduction" which is also a work of literary distinction. Her subject is nothing less than the life cycle studied as a whole, and this leads inevitably to the importance of a reformed agriculture for the health of the community. She saw the need for a popular introduction to her husband's revolutionary ideas and principles, and her book draws a vivid picture of what lies behind the appearance of the Earth's green carpet. "Nature is not concerned to give us simple lessons," Lady Howard says -- and yet she transmits them here with admirable simplicity and clarity, a delight to read. Truly a classic. Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

See a **review** of Albert Howard's work, plus a short bibliography and links to his major works and some of his published papers, at the Journey to Forever **Small Farms Library**.

Organic grower and author Steve Solomon's online **Soil and Health Library** is a treasurehouse of classic texts that are now almost impossible to find. There are no modern replacements for these books.
http://www.soilandhealth.org/

"Towards a Sustainable Agriculture -- The Living Soil", by Lady Eve Balfour. This classic text on the organic movement is an address given by the late Lady Eve Balfour, author of the organics classic "The Living Soil and the Haughley Experiment", to an IFOAM (International Federation of Organic Agriculture Movements) conference in Switzerland in 1977. Full text online at the Journey to Forever **Small Farms Library**.

Lady Eve Balfour at Haughley (The Soil Association)

"The Living Soil and the Haughley Experiment" by Lady Eve B. Balfour, Faber and Faber, London, 1943
Eve Balfour was a key figure in the forming of the organic gardening and farming movement, and one of the founders of Britain's Soil Association. She divided her estate at Haughley into two sections, one organic, and the other run "conventionally", with chemical fertilizers. This book records the results, and her insights. "The health of soil, plant, animal and man is one and indivisible," she said. She practised what she preached, and reaped the benefits -- Lady Eve died in her 90s, healthy and alert to the end. This is an informative, thoughtful and inspiring book any gardener will want to read. Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

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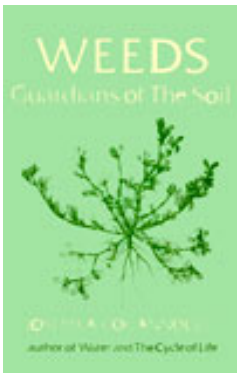
Ichijima
Japan

"**Pay Dirt -- Farming & Gardening with Composts"** by J.I. Rodale, with an introduction by Sir Albert Howard, Devin-Adair, 1946
Inspired by the work of Albert Howard, J.I. Rodale bought a farm, founded Organic Gardening Magazine, as well as Rodale Publishing, worked tirelessly to introduce organic farming to the US, and wrote this book. A good wrap-up of the subject. Full text online at the Journey to Forever **Small Farms Library**.

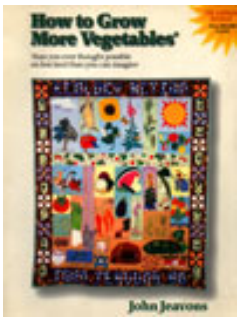
The **Medical Testament** published by the 31 doctors of the Cheshire Panel Committee in England on March 22 1939 was a milestone in the development of the infant organic farming movement. It acknowledged great advances in the realm of cures, but rather the opposite when it came to prevention. It also explained why this was so, and offered the remedy, plus the proof of it: "A fertile soil means healthy crops, healthy animals and healthy human beings." This is a classic document, now long out of print -- a lost classic. We tracked down a copy of the original pamphlet, plus some of the associated documents and publications -- 15 papers in all, virtually a book, all available in full-text online at the Journey to Forever **Small Farms Library**. This is what organics is all about.



"Weeds -- Guardians of the Soil" by Joseph A. Cocannouer, Devin-Adair, 1950. Professor Cocannouer, who taught biology and conservation for 50 years, demonstrates how the controlled use of weeds is sound ecology, good conservation and a boon to the gardener. Full text online at the **Small Farms Library**

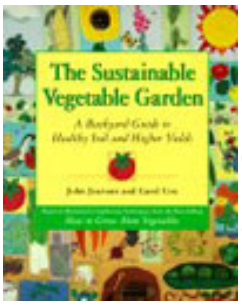
InterGarden -- a large and fine collection of resources on organics, Permaculture, sustainable agriculture, composting, renewable energy, literature, FAQs, lots of links and just about everything else you could want at Lawrence London's InterGarden site.
http://www.ibiblio.org/london/

Don't Panic Eat Organic ("An organic growers' homepage! It is growing like everything else around here!") -- it's hard to find anything about organics or anything related to organics that you can't find here. Very extensive indeed. And the site's had a quarter of a million visitors.
http://www.rain.org/~sals/my.html

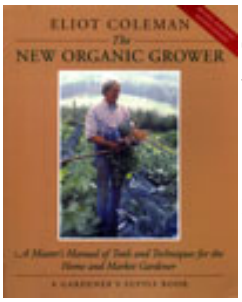


"How To Grow More Vegetables -- than you ever thought possible on less land than you can imagine" by John Jeavons, Ten Speed Press, Berkeley, California, 1974, 1995, ISBN 0-89815-767-6.
John Jeavons is director of Ecology Action, main protagonists of master gardener Alan Chadwick's Biointensive gardening method. Now in its fifth edition. Not just vegetables, also fruits, nuts, berries and other crops -- more crops on less land using much less water, achieving high yields while building soil fertility instead of depleting it. Ecology Action is helping to revolutionize sustainable gardening and

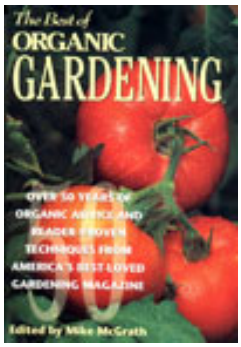
mini-farming in 108 countries around the world. "A gardener may be able to grow his or her own 322 pounds of vegetables and soft fruits in a four-to-six month growing season on as little as 100 square feet." This is a book to use -- bet you'll get it muddy! From Ecology Action:
http://www.growbiointensive.org/biointensive/book.html
Ecology Action home page:
http://www.growbiointensive.org/



"The Sustainable Vegetable Garden: A Backyard Guide to Healthy Soil and Higher Yields" by John Jeavons, Carol Cox, 1999, Ten Speed Press, ISBN 1580080162
This introduction to biointensive gardening shows that it is not only possible but easy to grow astonishing crops of healthful organic vegetable and fruits, while conserving resources and helping the soil. More than just an abridged version of Jeavons' ""How To Grow More Vegetables -- than you ever thought possible on less land than you can imagine", it makes many of the key concepts easier to understand and put into practice. It is full of useful diagrams which will be invaluable to the novice and expert alike. You don't just read about how to 'double dig' a bed -- there are step by step images to help you see exactly how it's done. Just about everything you need to know is covered, clearly and concisely. From Ecology Action:
http://www.growbiointensive.org/biointensive/book.html

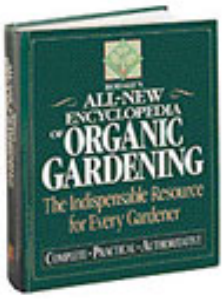


"The New Organic Grower -- A Master's Manual of Tools and Techniques for the Home and Market Gardener" by Eliot Coleman, Chelsea Green, Vermont, 1989, 1995, ISBN 0-939931-75-X
By a master -- "a quiet leader in the American organic movement" -- but this book is for anyone serious about the subject. Coleman is an organic farmer and gardening tools consultant, and he and his wife host the popular TV series "Gardening Naturally" on the Learning Channel. From Chelsea Green:
http://www.chelseagreen.com/Coleman/index.html



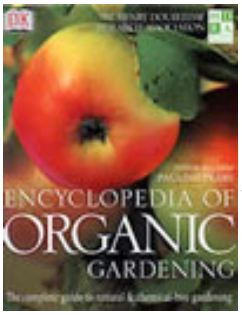
"The Best of Organic Gardening" edited by Mike McGrath of Rodale, Rodale Press, Pennsylvania, 1996, ISBN 0-87596-646-2
"Over 50 years of organic advice and reader-proven techniques from America's best-loved gardening magazine." J.I. Rodale was inspired by the work of Sir Albert Howard to found Rodale's organic research farm (now the Rodale Institute) and launch Organic Gardening magazine, and was the major influence in bringing organics to the US. This book is filled with organic savvy. From the Rodale Store:
http://WWW.rodalestore.com/webapp/commerce/servlet/ProductDisplay?merchant_rn=15336&prrfnbr=13126
Organic Gardening Magazine

http://www.organicgardening.com/

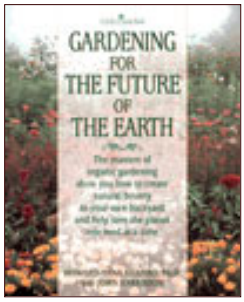


"Rodale's All-New Encyclopedia of Organic Gardening" -- a wealth of information distilled from Rodale's long years in the field of organic gardening and growing, from A-Z. Not only for organic gardeners but for all gardeners. From the Rodale Store: http://WWW.rodalestore.com/webapp/commerce/servlet/ProductDisplay?merchant_rn=15336&prrfnbr=13113

HDRA - the organic organization. Britain's premier organic gardening association has two large organic demonstration gardens, at Ryton and Spalding, runs an International Research Department, Information and Education Department, the Heritage Seed Library, Third World Organic Support Group and constant campaigns to promote the organic message. Also the new Schools Organic Network. The site has a useful set of factsheets and How-to guides (if you want to learn how to make compost this is a good place to start) -- good, practical, down-to-earth information you can use, based on years of answering inquiries from members and other gardeners. http://www.hdra.org.uk/



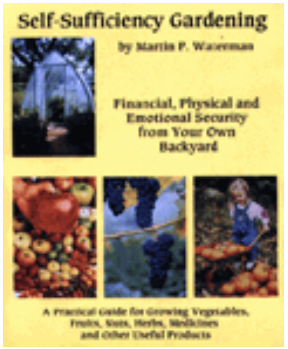
"The HDRA Encyclopedia of Organic Gardening", Dorling Kindersley, hardback, 416 pages -- The definitive organic gardening book, an essential reference for all gardeners committed to a natural, healthy and safe approach. It provides an excellent grounding in organic basics -- soil care, composting, weed control, plant health care and watering. Organic designs and plans, and chapters on ornamentals, lawns and hard landscaping help you to create your perfect organic garden. Fruit, vegetable and herb growing, outdoors, in containers and under cover is covered in detail to guide you in growing healthy, productive crops. Pauline Pears, Senior Horticultural Advisor and long-time HDRA member of staff, acted as Editor-in-Chief, co-ordinating the production for HDRA. http://www.hdra.org.uk/news/dk_book.htm



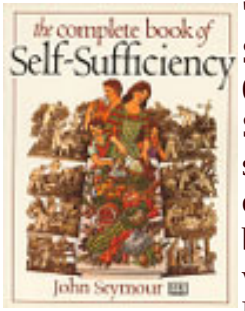
"Gardening For The Future Of The Earth" by Howard-Yana Shapiro, Ph.D., Agricultural Director, Seeds of Change, and John Harrisson, with Permaculture founder Bill Mollison, Biointensive master gardener John Jeavons, Alan York, Alan Kapuler, Carol Deppe, Wes Jackson and Masanobu Fukuoka ("The One Straw Revolution"). An all-star caste! Published by Seeds of Change, 2000, softcover, 240 pages, discounted Website price $18.95. http://store.yahoo.com/seedsofchange/garforfut.html

"Gardening Without Work: For the Aging, the Busy and the Indolent" by Ruth Stout, 1998, Lyons Press, ISBN 1558216545
Queen of Mulch Ruth Stout plants and picks, and that's all.

And she keeps her mulches thick: 6" thick. No weeds, no pests, no chemicals, no digging, no work. The first edition of this book came out decades ago and a whole generation of Stout fans have proved it works. Her engaging style makes this how-to book a lot of fun. Full of sage advice. Ruth Stout is living proof of her methods, and another tribute to organic gardening, like Eve Balfour: her latest book will be out soon: "Don't Forget to Smile or How to Stay Sane and Fit over Ninety". Order online from The Lyons Press:
http://lyonspress.com/gard_hort.asp



"Self-Sufficiency Gardening: Financial, Physical and Emotional Security from Your Own Backyard" by Martin P. Waterman, 1995, ISBN 1-55950-135-9
Waterman is a widely respected horticulturist and journalist. Practical guide for the novice and experienced gardeners. Covers the basics, organic growing, edible landscaping, greenhouses, preserving and storing, non-food and other valuable crops, earning income with your crops, and more. Traditional, time-honoured gardening techniques along with computer-gardening technology. Waterman writes gardening articles for Backwoods Home Magazine, among others. This is what the magazine's publisher Dave Duffy said about this book: "If you're going to read just one gardening book in the 90s, this is the book Backwoods Home Magazine will stand behind." From Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=1-1559501359-2
From Safety Central:
http://www.safetycentral.com/selgarbymarp.html



"The Complete Book of Self Sufficiency" by John Seymour, 1976, 1997, Dorling Kindersley, ISBN 0751304263
Seymour has been described as the 'guru' of self sufficiency and says it all in this book. From planning a 1 or 5 acre plot to crop rotation, from making bread to building a furnace. Essential accessory to self-sufficiency, whether you need to remove a tree stump, butcher livestock, harness a ploughhorse, plan a dairy or dress stone. Features many forgotten crafts that have been lost to convenience food and supermarkets. Comprehensive. Great drawings and all the information you need. From Amazon.co.uk:
http://www.amazon.co.uk/exec/obidos/ASIN/0751304263/qid=979231196/202-7185636-5219825

Raised Bed Agriculture -- Minifarms Network: "For home gardening raised bed agriculture means: less work, less irrigation, improved soil, higher yields and no poisons. For market gardeners, mini-farmers and mini-ranchers it means all the above plus profits. RBA creates a healthy soil to grow healthy plants to provide healthy food to feed healthy people." 2,200-word article

from Ken Hargesheimer in Texas, who has taught organic growing in permanent raised beds worldwide.
http://www.minifarms.com/rba.html

Biodynamics

The Biodynamics system of organic growing was founded by Rudolf Steiner: has its mystical side, along with high-quality results backed up by scientific research and studies. Biodynamics farmers make excellent compost using homeopathic plant preparations. The following two links are a good gateway to the world of biodynamic farming and growing.

Biodynamic Farming and Gardening Association (BDA) Home Page -- "Based on a series of lectures given by Austrian philosopher Rudolf Steiner in 1924, Biodynamics is a method of agriculture which seeks to actively work with the health-giving forces of nature. It is the oldest non-chemical agricultural movement, predating the organic agriculture movement by some 20 years and has now spread throughout the world."
http://www.biodynamics.com/

Captain Dot's Biodynamic and Organic Gardening Resource Site -- aimed at the backyard gardener who desires a deeper insight into the history, mystery and science of agriculture. Extensive links. Covers an overview of agriculture from its beginnings in Mesopotamia to the start of modern chemical agriculture, and the loss of soil fertility. Explores solutions to this problem embodied in the organic methodology of Albert Howard and the biodynamic movement founded by Rudolf Steiner. Suggested reading, sources of seeds, tools, biodynamic preparations.
http://www.biodynamic.net/

Permaculture

"Permaculture is a design system for creating sustainable human environments" -- Permaculture founder Bill Mollison.

Permaculture founder Bill Mollison

"Introduction to Permaculture: Concepts and Resources -- Alternative Farming Systems" from Appropriate Technology Transfer for Rural Areas (ATTRA), by Steve Diver, ATTRA Technical Specialist. Good introduction to permaculture, what it means and how to use it -- it was formerly The Permaculture FAQ.
http://www.attra.org/attra-pub/perma.html

Good permaculture coverage and resources at Lawrence London's excellent InterGarden site.
http://www.ibiblio.org/london/

Permaculture.Net -- US permaculture virtual headquarters. About Permaculture, courses & internships database, forum, resource list, bookstore, American Permaculture Directory, Permaculture Drylands Institute and Central Rocky Mountain Permaculture Institute. Along with a long list of definitions of Permaculture. Maybe this one is best: "Permaculture integrates

people into Nature's design."
http://www.permaculture.org/

Organics mailing lists

Set up in 1995, the **OGL list (Organic Gardening Discussion List)** hosts lively, informative discussions on a wide range of organic gardening and related topics. Send a message saying (in the body)
SUBSCRIBE OGL <Yourfirstname> <Yourlastname>
to
LISTSERV@LSV.UKY.EDU
All the messages sent by subscribers will arrive in your email box, or you can set the listserv to DIGEST format to send you one daily compilation of all that day's messages.

You can join the **Permaculture mailing list** online, at:
http://franklin.oit.unc.edu/cgi-bin/lyris.pl?enter=permaculture&text_mode=0
Also has searchable list archives.

The 4x4Garden email discussion group is for people using biointensive gardening methods to grow a tremendous amount of food or other crops in a small gardening space. Subscribe online:
http://groups.yahoo.com/group/4x4Garden
Post message: 4x4Garden@yahoogroups.com
Subscribe: 4x4Garden-subscribe@yahoogroups.com
Unsubscribe: 4x4Garden-unsubscribe@yahoogroups.com

Join the **Biodynamic gardening email discussion list** by sending your name and address to:
bd-l@biodynamics.com
Subject: Subscribe BD-L

Gardening resources

Organics resources
Square foot gardens
Companion planting
How much to grow?
General gardening
Herbs

City farms

Organic gardening

Why organic?
Building a square foot garden

Plant spacing guides
No ground? Use containers
When to sow what
Seeds
Garden pond
Gardening resources

Composting

Making compost
Composting resources
Composting indoors
Vermicomposting
Humanure
Composting for small farms

Small farms

Small farm resources
Community-supported farms
Farming with trees
Farming with animals
Pasture
Pigs for small farms
Poultry for small farms
Aquaculture for small farms
Composting for small farms
Controlling weeds and pests

Small farms library

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Small farms library
City farms
Organic gardening
- Journey to Forever organic garden
- Handmade soil
- Village development

Why organic?
- Do it for selfish reasons
- No pesticides
- Food quality

Building a square foot garden
- Where to build it
- Is the soil fertile enough?
- Raised beds and double-digging
- Paths
- The sides
- Sizes and shapes
- Trellises
- Cement
- Soil
- No compost?

Plant spacing guides
No ground? Use containers
- Container gardening guide
- Resources

When to sow what

Gardening resources

Square Foot gardens

UK "Square Foot" Gardening Pages
http://www.organicgarden.org.uk/

Part of the Journey to Forever square foot garden

Lots of information here! -- on square foot gardening, other square foot links and resources. Adds the essential element of organic gardening, weak or missing in some other square foot resources -- composting, companion planting and more.
Good place to start learning about Square Foot Gardening, introduces the idea and the benefits. Summarized square foot gardening tips.
http://www.organicgarden.org.uk/SqFt/sqfttips.htm
List of Plant Spacings for Square Foot Gardens:
http://www.organicgarden.org.uk/SqFt/sqftspacings.htm
Check the organics resources on Organic-UK's home page:
http://www.organicgarden.org.uk/

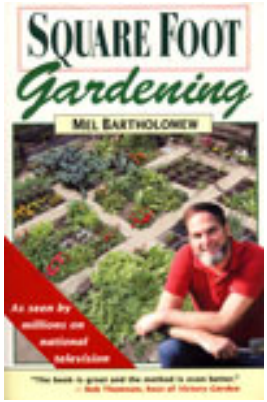
Farmer Brown's Garden Path Square Foot Gardening page
http://www.farmerbrown.org/sqft.html
Introduces square foot founder Mel Bartholomew, links to many square foot gardeners, schools, resources. One of the central sites of the square foot movement in the US.

Melissa Silvestre's **Square Foot Gardening**
http://members.primary.net/~silvest/garden/sqft.html
Square foot FAQ, tips, list of plant spacings, raised beds, building trellises, cooking information, and a link to the square foot listserv mailing list archive (searchable). Also a link to the rec.gardens Usenet newsgroup's five-part gardening FAQ (searchable).

The square foot gardening guide for teachers is a good general guide for square foot beginners -- **A Square Yard in the School Yard**:

Sowing times for different regions
Seed sowing and harvesting times for Hong Kong
Vegetable Garden Calendar for Hong Kong
Seeds
Catalogs
Supplies
Herbs
Hong Kong
Garden pond
Pond resources
Gardening resources
Organics resources
Square foot gardens
Companion planting
How much to grow?
General gardening
Herbs
Composting
Small farms
Home
What people are saying about us
About Handmade Projects
Sitemap (text only)
Projects
Community development
Why we're doing this
Rural development
Fixing what's broken
City farms
Edible cities
Organic gardening
Everyone can grow their own food
Composting
The Wheel of Life
Small farms

http://www.farmerbrown.org/manual.html



The book: **"Square Foot Gardening"** by Mel Bartholomew, Rodale Press, 1981, ISBN 0-87857-341-0. "Grow a perfect garden in only 10 minutes a day." Mel's system makes it easier to get better results in less space with less work -- and it helps answer a common gardening problem: how much to grow? http://www.squarefootgardening.com/html/catalog/book3.html

Square Foot pictures

Garden pictures by Steve and Paula Hicks in Arkansas. You can see how they made four 4x4 square foot garden boxes for raised beds, and "goal-post trellises" for vertical growing plants.
http://www.aristotle.net/~shicks/sqft/index.html

Different varieties of lettuce growing in their squares, at the Journey to Forever square foot garden

Square Foot Garden Manager -- PC software

Garden Manager 3.0, WinSite Package: garden3.exe download site
http://www.winsite.com/info/pc/win95/pim/garden3.exe/
What did you plant in that square last year after you pulled out the beans? Useful management and record-keeping shareware program written by square foot gardener Jonathan Maier (PCs only).

Square Foot mailing lists

Square Foot Gardening List

Subscribe/unsubscribe:
http://xena.pkiclue.com/mailman/listinfo/sqft-l
Subscribe by email:
sqft-l-request@xena.pkiclue.com?subject=subscribe
Unsubscribe by email:
sqft-l-request@xena.pkiclue.com?subject=unsubscribe
Post messages:
sqft-l@xena.pkiclue.com

The way forward
Biofuels
Fuel for the future
Solar box cookers
Sun power saves lives and trees
Trees, soil and water
Healthcare for mountains
Seeds of the world
No seeds, no food
Appropriate technology
What works and fits
Project vehicles
The workhorses

Internet
Why it really matters
Internet interaction
Finding your way

Schools projects
Introduction
Biofuels
Solar box cookers
Backpack stove
PicoTurbine
Low-tech radio
What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox
School gardens
School composting
Trees and forests
The Beach House fish pond
HOMeR
Eco-footprint
School and youth programs on the Web

Archive:
http://xena.pkiclue.com/mailman/private/sqft-l/
Archive of old messages from 1997:
http://www.hort.net/lists//sqft/

Square_Foot_Garden mailing list
Post message: Square_Foot_Garden@yahoogroups.com
Subscribe: Square_Foot_Garden-subscribe@yahoogroups.com
Unsubscribe:
Square_Foot_Garden-unsubscribe@yahoogroups.com
List URL: http://groups.yahoo.com/group/Square_Foot_Garden

Square Foot gardens for schools

A Square Yard in the School Yard -- a guide for teachers
http://www.farmerbrown.org/manual.html
Detailed guide for teachers to start Square Foot Gardens for their students, even with no gardening experience -- this TEACHER'S KIT tells you all!

Companion planting

"Companion planting helps bring a balanced eco-system to your landscape, allowing nature to do its job" -- not a chart, this is an extensive list of good companions with descriptions of how to use them from **Golden Harvest Organics** in Colorado.
http://www.ghorganics.com/page2.html

Vegetable Companion Chart from GardenGuides' Tips and Techniques
http://www.gardenguides.com/TipsandTechniques/vcomp.htm

Herb Companion Chart from GardenGuides' Tips and Techniques
http://www.gardenguides.com/TipsandTechniques/herbc.htm

Extensive tables of companion and antagonist plants in "**How To Grow More Vegetables** -- than you ever thought possible on less land than you can imagine" by John Jeavons of Ecology Action. (Book details)

Companion Planting: Basic Concepts & Resources, from ATTRA, Appropriate Technology Transfer for Rural Areas, in the US. Traditional Companion Planting charts, scientific foundations, good set of references and resources.

Education resources on the Web
Children's poetry

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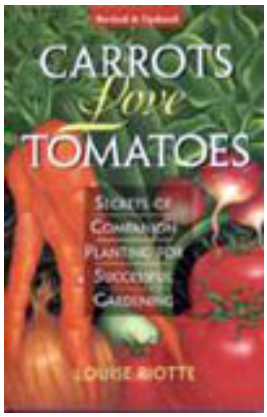
To Midori Hiraga
midori@journeytoforever.org
Homepage
http://journeytoforever.org/

Handmade Projects
Ichijima
Japan

http://www.attra.org/attra-pub/complant.html



"Carrots Love Tomatoes: Secrets of Companion Planting for Successful Gardening" by Louise Riotte, Storey Books, 2nd edition (March 1998), ISBN 1580170277 This gardening classic was first published in 1975. For gardeners who prefer pest-resistant planning to chemicals. Also, how to use herbal sprays to control insects, what wild plants to encourage in the garden, how to grow fruit and nut trees, how to start small plots or window-box gardens. Louise Riotte lists hundreds of plants and their ideal (and less than ideal) companions. Detailed line drawings. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/CarrotsLoveTomatoes.html

How much to grow?

John Jeavons

Self-sufficiency -- how much to grow to feed a family of five, in very little space.
http://www.organicgarden.org.uk/growing/grow/plantplan.html

Full plans for families to feed themselves in "**How To Grow More Vegetables** -- than you ever thought possible on less land than you can imagine" by John Jeavons of Ecology Action.

The **Michigan State University Preserving Food Database** lists the number of feet of row to plant for one person for each vegetable. Carrot Facts: Availability: mid July through October; Days to Maturity: 70-80 days; Approximate Yield/10 feet of row: 10 pounds; Per Person Requirements: Fresh: 5-10 feet of row, Preservation: 10-15 feet of row.
http://www.msue.msu.edu/msue/imp/mod01/master01.html

General gardening

The Garden Gate is a prime online resource for gardeners. The Gardener's Guide to Finding Answers on the Internet; the Teaching Garden -- extensive and well-organized collection of

glossaries, FAQs, special topic WWW pages, collections, and plant lists; Gardener's Guide to Mailing Lists; Gardener's Reading Room: e'zines, magazines online, magazine info, catalog info, catalogs online, book sources and reviews; Garden Shop, search, links to everything.
http://garden-gate.prairienet.org/

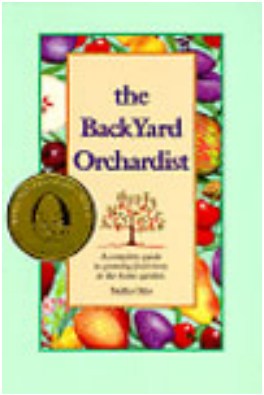
GardenNet says it's "the premier gateway to gardening on the Internet." It's certainly comprehensive, with a huge set of well-organized links to resources for gardeners. Plus the new online magazine GardenMatters.com -- "The Journal at the Heart of Gardening" about the joy and fun of gardening from gardeners and garden writers around the world.
http://gardennet.com/

The Garden Web is the place for gardeners' online forums -- it claims to host the largest community of international gardeners on the Internet. Forums on a wide variety of gardening topics.
http://www.gardenweb.com/forums/

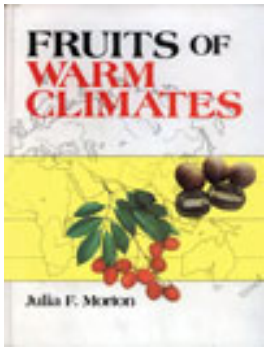
Excellent set of selected gardening links in 345 categories at the **Premier Roses** site -- comprehensive! And if you like roses, this is the place for you.
http://www.premroses.com/

The Gardening Launch Pad -- Master Composter and National Flower Show Judge Jim Parra's Launch Pad has 4,556 gardening links in 100 categories, focus on the Home Gardener, 96% of these links are content links, not commerical links.
http://www.gardeninglaunchpad.com/

California Rare Fruit Growers (CRFG) is the largest amateur fruit-growing organization in the world. Fruit Facts online -- botanical identification, plant description and culture notes, characteristics of cultivars for 43 fruit varieties -- Common Names, Origin, Species, Related species, Adaptation; Description: Growth Habit, Foliage, Flowers, Fruits; Culture: Location, Soil, Irrigation, Fertilization, Frost Protection, Pruning, Propagation, Pests and Diseases, Fruit Harvest; Cultivars; Further Reading, and a direct link to Index of CRFG Publications, 1969--89. Also The Fruit Gardener magazine, descriptions of 250 rare and unusual edible plants, Seed Bank, the CRFG Fruit List -- Common Name, Genus species, Family, and Fruit Cultural Data, by genus name. Plus a large set of fruit and related links. Exhaustive! Excellent resource.
http://www.crfg.org/



"The Backyard Orchardist: A Complete Guide to Growing Fruit Trees in the Home Garden" by Stella Otto, revised edition 1995, Otto Graphics, ISBN 0963452037
Step-by-step guidance from a true expert on how to start your orchard -- planning, soil, tree selection for your climate, planting, pruning, pest management, harvesting and storing, everything you need to know. From Powell's Books:
http://www.powells.com/biblio/126200-126400/0963452037.html
From Chelsea Green:
http://www.chelseagreen.com/DP/Otto/BYOrchardist.htm

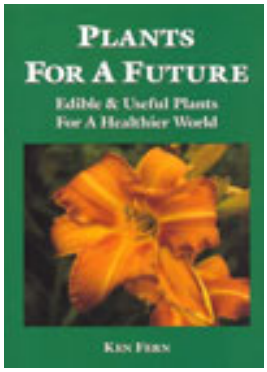


"Fruits of Warm Climates" by Julia F. Morton, ISBN: 0-9610184-1-0
Julia F. Morton is Research Professor of Biology and Director of the Morton Collectanea, University of Miami, a research and information center devoted to economic botany. Covers 124 species, with an extensive bibliography; the entry for each species is a minor essay, with detailed treatment under Description, Origin and Distribution, Varieties, Climate, Soil, Propagation, Culture, Keeping Quality, Pests and Diseases, Food Uses, Other Uses. The approach is global -- Uses, for instance, covers the practices of traditional peoples throughout the world, including medical uses. Ms Morton provides a real wealth of information from her long experience of the subject. With photographs. Full text online:
http://www.hort.purdue.edu/newcrop/morton/index.html

"The Complete Book of Edible Landscaping -- Home Landscaping with Food-bearing Plants and Resource-saving Techniques" by Rosalind Creasy, 1982, Sierra Club, ISBN 0871562782
Thorough treatment, practical, how-to advice from a seasoned landscape designer and consultant, well-illustrated. Energy, water and soil-saving techniques for different regions. Includes a 160-page encyclopaedia of edible plants with cultural details, landscaping, culinary uses, sources and recipes. Large list of plant and seed suppliers. "Head and shoulders above the rest" of the books on this subject, says a master gardener. From the

Sierra Club:
http://www.sierraclub.org/books/catalog/0871562782.asp

"Cornucopia II -- A Source Book of Edible Plants" by Stephen Facciola, Kampong, ISBN 0962808725
Encyclopaedia of about 3,000 edible plants, alphabetical listing of plant families with 300 pages describing 7,000 varieties, especially traditional and heirloom varieties, and promising new releases. Habitat, origin, cultivation, preparation, modern and ancient uses, and 1,300 sources for seed, plants and rootstock, produce and other foodstuffs. In addition to common and botanical name cross-referencing there is an index of plants listed by use and edible parts. Wonderful work of scholarship. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/CornucopiaII.html



"Plants for a Future: Edible and Useful Plants for a Healthier World" by Ken Fern, 2000, Permanent Publications, ISBN 1856230112
The way we currently produce our food is damaging both to ourselves and our planet. We need to create gardens, woodlands and farms which are in harmony with nature. What we need is to discover and grow a wide variety of easily grown perennial and self-seeding annuals which provide delicious and healthy food, or are useful in other ways. Describing plants such as these, native to Britain and Europe and from temperate areas around the world, this book includes those suitable for: the ornamental garden, the edible lawn, shade, ponds, walls, hedges, agroforestry and conservation. Packed with information, personal anecdote and detailed appendices and indexes, this pioneering book takes gardening, conservation and ecology into a new dimension. "Ken Fern leads us through a garden of improbable delights -- cold climate yams five feet long, edible fuschia fruits, trees laden with delicious berries all through the winter, leaves and flowers with the most subtle and astonishing flavours. It is hard to over-estimate the importance and likely impact of this book. The result of an insatiable curiosity and years of painstaking research, this book is comparable in stature only to the works of Evelyn and Culpeper." -- George Monbiot, The Guardian. Order from Plants For A Future:

http://www.comp.leeds.ac.uk/pfaf/book.html
See the Plants For A Future online database.

Mother Earth News Online -- Best stories over 30 years of getting back to the land (online), current issue, site search. "Back fence" -- bulletin boards; "Ask Mother" -- questions "on anything under the sun".
http://www.motherearthnews.com/
Archive -- most issues from #1 in 1970. Issue Index
http://www.motherearthnews.com/index.php?page=archindex
Archive Search
http://www.motherearthnews.com/index.php?page=archive

Horticulture factsheets -- Nebraska Extension Publications: large, well-organized list of factsheets, how-to's, resources on ornamentals, fruits, vegetables, turf, general gardening. Useful online reference book.
http://www.ianr.unl.edu/pubs/horticulture/

Dig Magazine: Home & Garden Diversions -- Forum, maintenance, mailing list, resources. Lots of categories to explore, back issues, articles, and a site search.
http://www.digmagazine.com/

The History of Gardening Timeline from Ancient Times to the 20th Century -- "Noteworthy Publications, Persons, and Events in the History of Gardening. Including some Related Information from Agriculture, Natural History, Botany, and Ecology." This award-winning site tells a fascinating story and tells it well, starting 10,000 years ago -- From Ancient Times to 1700, the 18th Century, the 19th Century, the 20th Century, plus a great list of reference sources. Part of Mike Garofalo's The Spirit of Gardening website, a great place for gardeners.
http://www.gardendigest.com/index.htm

Illustrated instructions for making **a garden in a bottle** at the Echo Island Gardening Page. For Begonia, Asparagus Fern, Lady Fern, Slow-growing Ivy. The garden doesn't need watering for months on end.
http://www.rte.ie/tv/echo/digit.htm

Plant databases

The New Crop Resource Online Program at Purdue

University, includes CropSEARCH -- a key word search engine to access crop information, CropINDEX -- a list of scientific and common names of crops for information access, CropREFERENCE -- books and manuals on crops, Aromatic-MedicinalPLANTS -- a guide to aromatic & medicinal plants, culinary herbs & spices, NewCrop LISTSERV -- an interactive bulletin board for queries, discussion, and information on crops, and much more. Easy access to a huge set of resources on crops new and old, trees, plants of all kinds. "The most comprehensive library and compilation of new and alternative crop information available on the web." Very useful indeed.

http://www.hort.purdue.edu/newcrop/

Plants For A Future -- A resource centre for edible and other useful plants. Database Search has a variety of powerful searches of very large plant resources. Search by Name (common or family), Edible, Medicinal or Other Use, Native Area, Habitat, word search, Latin names. You can download the database for your own use. Home page:
http://www.comp.leeds.ac.uk/pfaf/index.html
Search page:
http://www.ibiblio.org/pfaf/D_search.html

Poisonous Plants at Cornell University's Animal Science Department includes plant images and information on the botany, chemistry, toxicology, diagnosis and prevention, linked to related resources. Database search.
http://www.ansci.cornell.edu/plants/plants.html

See also Herb databases below.

Herbs

> -- "Herbs and plants are medical jewels gracing the woods, fields and lanes which few eyes see, and few minds understand. Through this want of observation and knowledge the world suffers immense loss." -- Linnaeus 1707--78

"Culpeper: The Complete Herbal" by Nicholas Culpeper, 1653 -- "being an astrologo-physical discourse of the common herbs of the nation; containing a complete Method or Practise of

Physic, whereby a Man may preserve his Body in Health, or cure himself when sick, with such things only as grow in England, they being most fit for English Constitutions." Dr Johnson said: "Culpeper, the man that first ranged the woods and climbed the mountains in search of medicinal and salutary herbs, undoubtedly merited the gratitude of posterity." And received it -- the Herbal was the basis of all subsequent herbalism in the English-speaking world, and has probably never been out of print in 350 years. And now it's online.
http://www.bibliomania.com/NonFiction/Culpeper/Herbal/

A Modern Herbal, 1931, by Mrs. M. Grieve. Over 800 varieties of medicinal, culinary, and cosmetic herbs, including economic properties, cultivation and folk-lore, online in hypertext, with a word search of all 860 pages.
http://www.botanical.com/botanical/mgmh/mgmh.html

Köhler's Medizinal Pflanzen (Kohler's Medicinal Plants) -- wonderful botanical illustrations online, from Missouri Botanical Garden. Tour, thumbnails of illustrations, text listing of scientific names, search. Large images.
http://ridgwaydb.mobot.org/mobot/rarebooks/title.asp?relation=QK99A1K6318831914

Richters Herbs -- Medicinal, Culinary, Aromatic. This is a great website, packed with information on the wonderful subject of herbs. Also publishes Richters HerbLetter, sent to you by email, a real treasurehouse, top of its class by far.
http://www.richters.com/

Herb World is the website of the Herb Growing & Marketing Network, a trade association with around 2,000 members, and acts as an information service for members (and anyone else). Features The Herbal Green Pages Online, Herbal Exchange, Botanical Dictionary, Herb Source, Potpourri (great links to informational herb sites), Herbal Exchange, the Herbalpedia monthly monograph series.
http://www.herbworld.com/

Herb databases

The Guide to Medicinal and Aromatic Plants at Purdue

University's Center for New Crops and Plant Products includes Plant/Crop Descriptors -- information about each herb plant in alphabetical order by common and Latin names; Plant/Crop Production Guides -- in-depth fact sheets; Guide to Herb Varieties -- herb varieties available from commercial sources; Sources of Herb Seeds and Plants, research archive, citations database, Other Sources/References, links, Directory of Experts.
http://www.hort.purdue.edu/newcrop/med-aro/default.html

Phytochemical and Ethnobotanical Databases -- Dr James Duke is a foremost expert on medicinal plants, and his site (hosted by the US Agricultural Research Service) contains an amazing collection of herbal knowledge. Excellent resource.
http://www.ars-grin.gov/duke/index.html

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Vermicomposting

Making compost

Good compost

It's easy to make good compost. Quite a lot of people make some kind of compost, but you couldn't say it's "good". It's no more trouble making a really good product -- in fact it's less trouble, because good compost reduces almost every other kind of gardening problem. So why not get it right in the first place? This guide is about making GOOD compost.

Compost ready for turning

There's a lot of discussion about all the technicalities involved in what constitutes "good" compost, but we reckon good compost is either compost that gets HOT -- 60 degrees Centigrade (140 deg Fahrenheit) or more -- or it's **Vermicompost**, made for you by special earthworms.

How not to fail

It's a common mistake to use too much water -- it's probably the most common reason for failures. (Others are not enough nitrogen, and, more rarely, no aeration.) The overall moisture content of the assembled pile should be about 60--65%. They say it should be as moist as a wrung-out sponge, which is a good guide if you've put everything through a shredder so it's homogenized and the particle-size is small, but with the usual rough compost materials it's not very useful.

This is typical advice: "Spray the mixed materials with a hose until wet like a sponge but not soggy. Fork it into the bin, spray more water to make sure it is wet enough."

Beginners read such things and end up with a disaster. When the stuff starts to decay it disintegrates into a slimy, stinking sludge, like what happens to grass clippings if you leave them in a big pile: it gets very hot, and then it dies into a dark green gunge -- much worse if there's manure and kitchen scraps in it! And it's

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Midori filling a compost bin

difficult to repair the damage and get it working properly. That's often the end of that particular beginner's composting efforts.

Compost materials are often much wetter than they look at first. Fresh green leaves can be 95% water, but they don't *look* wet. Kitchen wastes are usually more than 85% water. Spreading fresh greens out and letting them wilt for a day loses a lot of the water, and probably quite a lot of the nitrogen too, unfortunately. Manure is a lot easier to handle if it's on the dry side, which also loses a bit of the nitrogen.

There's another way of going about this.

Greens and browns

Compost materials are assembled in the correct proportion of "Greens" (nitrogen-rich) and "Browns" (carbon-rich) to achieve an overall carbon/nitrogen ratio of 25-30:1 (**Virtual composter, and Compost Calculations from Rodale**). Put simply, fresh green matter such as grass clippings, vegetable wastes, fresh leaves, etc, contain a lot of nitrogen. So does manure, bloodmeal, kitchen scraps, alfalfa meal, and hay. Fallen leaves, straw, sawdust, shredded newspaper and cardboard, wood chips -- browns -- contain high proportions of carbon.

Keith turning compost at the Beach House

Instead of thinking in "greens" and "browns", think in terms of "wets" and dries". In fact wets are usually green, and browns are often dry. You can make sure the browns are dry -- collect fallen leaves when the weather's dry, for instance. Presume your compost materials will always be too wet, and always have lots of dry browns on hand to balance it with. Too much carbon? We'll deal with that in a minute.

The advantage of dry browns is that you can store them

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indefinitely, unlike wet greens. With a bit of foresight and effort you can always have a few garbage bags filled with dries ready for when you need them. Make a big effort in autumn -- collect enough leaves for the whole year.

Hints

1. Not enough water is better than too much water. Too much water is a usually a disaster, but if there's not enough, the pile will heat up and then stop. Empty it out, loosen it all up with the compost fork, add more moisture, and put it back in the box again, no big deal. Soon you'll learn how much water is enough. If your pile is too wet, try emptying it, fluff it out, add more dry stuff, and some dry greens if you have such a thing (bloodmeal, peanut cake, alfalfa meal), and rebuild it. It might work.

2. Too much nitrogen is better than not enough nitrogen. If there's not enough the pile will just sit there forever, nothing happens for a year or two. If there's too much the pile will heat up well and simply blow off the excess with the steam in the form of ammonia gas, until the balance is right. But isn't that a waste of precious nitrogen? No -- nitrogen's only precious if you're dumb enough to buy it from a chemical company (see below, **Adding liquids**). Again, this way you'll soon learn how much is enough.

3. Roots: shake as much soil as you can off clumped roots before putting them in the compost. Many people put much too much soil in the compost with the roots, and it clogs everything up. But always have *some* soil sprinkled throughout the pile. It helps to inoculate the compost with the beneficial soil microorganisms that make the process happen, especially if you're not using animal manure, and clay particles in the soil help to spread a thin film of moisture throughout the pile, which is just what you want.

4. Useful additions: Lime, or, better, ground limestone, the finer ground the better. Liquid seaweed emulsion, such as Maxicrop, SM-3 or equivalent -- all the minerals for all the soilbugs, in easily digestible forms. Compost or compost siftings from the previous batch to inoculate the pile. Sprinklings of ground rock powders are useful.

5. Newsprint: Modern printing inks are almost always non-toxic and biodegradeable, particularly black ink, so don't be shy of using shredded newspaper (very "brown").

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Children's poetry

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Compost containers

If you have really big supplies of organic wastes, make windrows, 8ft at the base, 5-6ft high, with sloping sides, and as long as you like. Otherwise prefer boxes or bins to heaps. If you're expert enough you can make a steep-sided heap, even a sheer-sided one, otherwise it degenerates into a mound, which is not efficient -- unless you're making an expert Biodynamic compost heap, that is.

Boxes and bins have sheer sides, and protect the compost from the elements. There are endless different designs -- see HDRA -- Building a compost bin for instructions on making a simple, flexible box system.

Here's how to make a wire mesh bin.

A chickenwire compost bin (Beach House style) on the left. When cooked, you can open the wire mesh and work on the pile (centre). Cardboard boxes (right) also make a good compost bin

Make a "tube" of chickenwire, 3ft in diameter. Leave about 8-10" overlap, and connect the ends with four twists of wire each. You'll need about 10.5ft of 3ft-wide mesh, and two more pieces each 3ft long -- total 16.5ft.

Line the bin with a garbage bag, or two bags, with the bottoms cut off, to keep the moisture in. Have the liner flush with one end, and overlapping the other (that's the top).

Make a 3ft square of four bricks, one at each corner, with a fifth in the middle, and put a 3ft square of tough wire grille such as pig fencing on the bricks. Put one of the two 3ft-square pieces of chickenwire on top of that. Stand the mesh bin on end on top of this aerated base. Now you can fill it with compost material.

When it's full, depending on the weather, you can close it loosely with the garbage bag overlap, again to keep the moisture in; when it starts steaming, open the bag, if it seems to be getting dry, close it again.

Cover the top with the second 3ft-square piece of chickenwire, and clip it on, to dissuade wildlife. If it's in the open, cover the top with a garbage bag to keep the rain out.

You'll need two of these bins -- you always need at least two compost bins/boxes: when one's full, you start filling the next one. By the time that one's full, the first one is finished and can be emptied.

Assembling the materials

It's easier to make good compost if you have enough materials to fill the box at one go. If not, see below, **Batches**. See HDRA -- How to make compost, for good information on which materials to use and how to use them. Basically, anything that was once alive or part of something alive can be composted. This is the recipe: the assembled pile should have 60--65% moisture content, good aeration, acid-alkaline level about neutral (pH 7) or slightly acid (pH 6-6.5), carbon/nitrogen ration 25-30:1 (**Virtual composter, and Compost Calculations from Rodale**).

First, collect all the greens together and mix them thoroughly with a compost fork. If anything's too big to mix, chop it up into 4-6" lengths with the edge of a spade or a chopper.

A compost fork -- the perfect tool for composting, 4-tined or 5-tined

Up to 10% of the material can be rough material like small sticks and prunings -- they probably won't break down but they'll help with aeration and prevent the material packing down and clogging up too much.

Assemble all the ingredients in a sort of big pancake (5-6ft diameter) in front of the open box (leave yourself enough room around it to work).

Put wet greens on top of dry browns. Use a 5-gallon bucket or a basket. Spread out two buckets of browns (pack it in) and then one bucket of greens on top.

Do that twice, then add some sprinklings: a handful of ground limestone or wood ash (sprinkle it like icing sugar on a sponge cake), some bonemeal if

you have it, a handful or two of soil, and a couple of handsful of compost (unless you're using the siftings from the previous batch -- mix with the browns if they're dry enough). Scuff over the surface to bury the sprinklings a bit, then add liquid (see below, **Adding liquids**) -- 1-2 litres, with a sprinkling can. If you must use a hose, set the nozzle to a fine mist.

Mixing the layered material before putting it in the bin

Repeat this whole layering process two or three more times or until you've used all the materials.

Now work from the edge of the layered pancake: rake off about 1ft with the compost fork, mix it up well, and fork it into the box, spreading it evenly and tamping it down firmly (but not too tight). Layering it and then mixing vertical slices this way gets it thoroughly mixed and evenly distributed. Then do the next foot, and continue until it's all in. Sweep up fines as you go, sprinkling them into the box with a shovel.

Aeration

Compost needs air from underneath. You can put the box on the soil, if it's good soil that breathes well. Even then, loosen it well with a fork to a depth of about 12 inches. An advantage of this is that if the pile is too wet some of the excess water might drain off into the soil. (Or it might not.)

Turning the pile aerates and mixes it thoroughly to burn a second time

Alternatively make a base like that for the wire mesh bin described above: make a 3ft square of four bricks, one at each corner, with a fifth in the middle, and put a 3ft square of tough wire grille such as pig fencing on the bricks. Put a 3ft-square piece of chicken wire on top of that, and stand the box on this base.

When filling the box, stand a 5ft length of bamboo or a broomstick upright in the middle until the box is full. Then shake it from side to side a bit (an inch or two) and pull it out. Or

make vertical holes every 6" or so across the top with a piece of rebar, push it right down until you hit the wire mesh at the bottom. Now your compost can breathe easily.

Put a lid on the box when it's full, not airtight, but wildlife-proof, and waterproof if it's in the open.

That's it. By the next day the temperature should be above 50 deg C, and it should climb to 60 deg or higher. You can turn it after a week or two when the temperature's fallen to about 40 deg, or just leave it for another couple of weeks instead.

Get a soil thermometer, or any long thermometer that will reach the centre of the pile to monitor the temperature. Or just put your hand in -- if it's too hot to keep it there, it's fine.

Adding liquids

The best form of liquid addition for compost is what some composters primly call Household Compost Activator. Other people call it urine. Don't be coy about it -- this is what *should* happen to urine rather than wasting it by flushing it down the toilet. Develop a self-righteous attitude about not wasting it -- but don't shout about it too loud, modern city people like neighbours and so on can be funny about these things, what they don't know won't hurt them.

First, urine is sterile. Second, it contains the drainage of every cell in the body -- it's crammed with minerals and vitamins. Third, it contains a lot of nitrogen -- that's one reason that it's silly to buy nitrogen (there are others).

It shouldn't prove too difficult to arrange to have a few litres of Household Compost Activator set by when it's time to make the compost. You can use it neat, or mix it 50-50 with water, and add a capful of seaweed emulsion while you're at it. Use a sprinkling can.

For further information and reassurance on this matter, see: **Container Farming -- Organic food production in the slums of Mexico City**

More about nitrogen: well-made compost piles often end up containing more nitrogen than they started off with -- up to 25% more. It's provided by free-living nitrogen-fixing bacteria that thrive in a compost pile and "fix" nitrogen from the copious

supplies in the air.

Batches

Smaller gardens won't provide enough material to fill a 15 cub ft compost unit at one go, it comes in dribs and drabs. So do kitchen scraps. You could just throw it all in a compost bin as it comes, but it'll probably be too wet and clog up, or it won't get hot, or only quite hot (mesophilic) rather than very hot (thermophilic), which is better than nothing. It's worth organizing the process by gearing garden wastes to kitchen scraps and then processing it all in batches until the bin is full.

Kitchen scraps

Get a smallish (10-12") plastic bucket with a lid, and a tray that it can stand in. Drill some holes in the bottom. Put 3" of dry stuff in the bottom, add your kitchen scraps on top as they're produced. Keep the bucket in the kitchen. No meat/fish etc or cooked food until you're more experienced (eggshells are fine). If you're a big family you might need a bigger bucket.

Don't let it get too wet, don't let it go rotten -- if liquid starts coming out the bottom, empty it (every few days, depending how much you cook).

Meanwhile collect garden wastes and odds and ends of greens -- they'll keep for a while if you spread them out somewhere dry in a layer a few inches deep.

For the first batch, put 4" inches of dry stuff in the bottom of the compost bin. Mix up greens and kitchen wastes, add some manure if you have it. Then mix it up with twice the quantity of browns/dries, add sprinklings of lime or wood ash, bonemeal, some dry compost, as above ("Assembling the pile"), and a bit of liquid if necessary, and dump it in the bin, spreading it evenly. Pack it down quite tightly.

Add an inch or two of browns plus a sprinkling of compost or topsoil on top. The first batch might not have the bulk to get hot, which normally eradicates the smell of the kitchen scraps (and anything else), and a layer of browns on top will help keep flies away. As further batches increase the bulk it should heat up well. Put a lid on the bin.

Once it cools down it should be turned -- empty the bin, fluff everything up thoroughly with the compost fork, add liquid if

necessary, and put it back in the bin. If it doesn't get that hot the second time, never mind, just leave it there for a few weeks.

See also **What to do with a cardboard carton -- Composting**

Animal manure

Many people say it's not essential to use animal manure to make good compost, and that's true. Some people actively avoid it. But it's better to use manure, if you can get it. All natural topsoil is derived from a mixture of animal and plant matter -- nature never attempts to raise plants without animals. It's important that some portion of what's recycled into the soil should have passed through animals. This is one of the reasons we recommend using urine as an activator.

Buffalo dung from the local herd

Manure from any animal that's not a carnivore will do, plus poultry. The Biodynamic school of organic growing -- ace compost makers -- swears by cowdung, ascribing special qualities to it. In Hong Kong we used manure from the herd of feral water buffalo who were our neighbours, and it was excellent. A fifth of the total amount of compost material is enough manure, don't use more than a quarter.

Beware of manure from factory-farmed livestock that's fed commercial feed laced with antibiotics. You can use it, it'll probably work okay, and the antibiotics will break down in the heat, but why put stuff in your compost that'll kill the very critters that do all the work for you?

Sifting

If you've got a shredder, you can shred the materials before you load the box, shred them again a week later, and maybe again a week after that, and then you won't need to sift the compost. Otherwise it'll need screening.

There are many different screening systems. Simplest is a 5ft x 3ft-wide piece of 5/8th-inch or 3/4-inch wire screen wire-stapled

Keith sifting the finished compost

to a light wooden frame. Stand it at an angle against a wall and throw the compost at it with a shovel (aim high). Or use it horizontal to the ground, supported at each end at a height of 3-4ft, shovel the compost onto it and rub it through the screen with your hands (use gardening gloves) or with the back of a garden rake.

Store what goes through the screen for a few weeks to let it cure before using it in the soil. When applying it to the soil, hoe it lightly into the top few inches where it'll do the most good. The earthworms will do the rest. No earthworms? Don't worry, there soon will be!

You'll be left with up to a quarter of the pile in siftings. It makes a very good mulch, or you can add it to the browns for the next lot, or mix it with kitchen scraps and greens for batch composting.

Cold weather

A person who said he'd made "lots of compost" wrote: "In northern climes especially, you're more in need of adding heat to the pile some of the year... The problem here in Wisconsin is it just gets too cold in winter. I know, I've tried it, it froze solid in the winter. Somewhere I've seen plans for a solar heated outhouse, and solar heated compost bin, which would probably be the ticket."

That's just not how compost works. If it's correctly prepared, the biological activity will heat it up, no matter how cold the weather is. Adding extra heat from outside is no use.

Finally he admitted: "I don't think my compost piles ever heat up much. Not enough nitrogen for one thing, here in town. I suppose if you had a large batch of materials mixed up properly with the correct ratios, it might have a chance, but you can't do that with the daily wastes." Yes you can.

As for not enough nitrogen, a strange statement indeed, he then read this: **Container Farming -- Organic food production in the slums of Mexico City**. He'll be trying "Household Compost

Activator" next year.

Elaine Ingham, President, Soil Foodweb Inc., wrote: "The definition of properly composted material, when applied to thermal compost, is that it has reached temperature throughout the material for long enough that weed seed, human pathogens and most of the plant pathogens and pests have been killed... Many people do not understand that the bacteria and fungi growing in organic matter raise the temperature. If all you do is physically heat compost, you don't get the same reduction in [pathogens]. This is a biological process. Competition with aerobic bacteria and fungi, inhibition by other bacteria and fungi, and consumption of disease-organisms by protozoa and nematodes are all part of the process of making good compost, getting rid of the pathogens. If you just steam heat organic matter, you don't get the same benefits of the growth of the competitive, inhibitory and consuming interactions that happen when the full food web is present." -- Sustainable Agriculture Network Discussion Group, 5 November 2002
http://www.soilfoodweb.com/phpweb/

"Even in Alaska -- in the middle of the winter -- my compost pile reaches 140 degrees or more. If it gets too hot, beneficials, such as worms, simply move (crawl) out of harm's way. Turn pile every 4 or 5 days, folding ouside materials to the inside and versa visa, like kneading bread. Keep it moist, not soggy, and be glad you're making 'post! Nice work!" -- Marion, message to the GardeningOrganically Internet mailing list, 26 September 2002

We've made compost outside in the usual way at temperatures of -15 deg C (5 deg F) with no difficulty, the compost rose to 65 deg C (150 deg F) as usual.

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Vermicomposting

Composting resources

Virtual composting

We could easily show you how to do it, but can you learn such a practical, down-to-earth, hands-on technique as composting from the Internet? Keith learnt it from a book, or several books, but he says it wasn't easy (and he's real stubborn). In fact there are vast resources on every aspect of composting on the Internet, and it's a LOT better than a book! Keep at it and you'll get there, it's easy really. Along with the guidelines above, we recommend the first four resources below as your basic how-to guides.

Composting for dummies (and aren't we all)

HDRA -- Britain's HDRA Organic Association receives hundreds of enquiries on organic gardening every day, and years of answering them, along with the Association's vast on-the-ground experience, have helped to produce some of the best practical guides available. The following two online factsheets are a great help for beginning composters.

HDRA -- Building a compost bin. How to make a moveable, wooden compost box consisting of identical interlocking sections which are stacked one on top of the other. As the compost decreases in volume, the top sections of the box can be taken off and used to start building up a new container. Make a few extra sections and you will have a very flexible composting system. Keep the rain out with a wooden lid or square of old carpet or polythene. Makes a square compost box 75x75x75cm. Uses reclaimed timber such as floorboards or pallets.
http://www.hdra.org.uk/factsheets/gg24.htm

HDRA -- How to make compost. "Making your own compost from garden and household waste is one of the best things any gardener can do. It's easy and costs very little in time or effort." What can I compost? -- Hotter rotters (activators) -- A balanced diet -- Slow cookers (very slow to rot) -- Other

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compostable items -- Best avoided -- Do NOT compost. Compost cool, compost HOT. Compost hints and tips, Some questions answered.
http://www.hdra.org.uk/gh_comp.htm

If you live in the UK, there are regular half-day courses at the HDRA headquarters at Ryton Organic Gardens. Contact the Marketing Department Tel (024) 7630 8211 or email Sally Furness for more details: sfurness@hdra.org.uk

Virtual composter
Florida's Online Composting Center has a Quick Tutorial -- how to compost in five easy steps; a more detailed "Compost Happens!" Tutorial takes about 20 to 40 minutes. Also Learn More, Site Search, and a useful troubleshooting guide. The Virtual Pile (Java) calculates the carbon to nitrogen ratio for you. This is a good way to get a feel for balancing the materials. Drag up to 12 items into the bin, view the C:N ratio as you build the virtual pile: comments help you build your real pile at home. Choice of Table scraps, Fruit wastes, Green leaves, Dry leaves and pine needles, Cow manure, Grass clippings, Horse manure with litter, Wet paper or paperboard, Coffee grounds.
http://www.compostinfo.com/cn/Default.htm

Compost Calculations from Rodale -- tables to calculate the right amounts of "Greens" (nitrogen) and "Browns" (carbon) needed to make your compost heap get HOT! Composting is simple when you follow the rules: a moisture content of 60-65%, enough bulk (at least 10 cubic feet), a good air supply, and a carbon/nitrogen ratio of about 30:1. The last bit's not as difficult as it sounds. These simple tables will help you get a feel for it, and soon you won't need them anymore. Divide the figure for carbon % by the figure for nitrogen %: if the answer's less than 30, it's "green" -- even if it's actually brown, like cowdung (12-25) or coffee grounds (25); if it's more than 30, it's "brown".
http://www.organicgardening.com/library/compost_ratios.html
Also Composting Lingo -- a useful glossary of composting terms and what they mean:
http://www.organicgardening.com/library/compost_lingo.html

"Organic Gardener's Composting" by Steve Solomon, 1993, Van Patten, Oregon
How to do it right and why it's worth it -- a good guide, simple and clear treatment of what can be a most complex subject. Two subjects in one book: a basic, how-to-make-compost book in Part One; and how to make really good compost in Part Two, along with an analysis of the nutritional consequences of soil fertility

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management choices. Focuses on thermophilic (hot) composting and vermicomposting (worms) -- ie, *real* compost. Summarizes the work of the great compost developers like Howard and Rodale, along with the revolutionary wholistic health concepts of Weston A. Price and Sir Robert McCarrison. Out of print but online:
http://www.soilandhealth.org/

Core texts

"The Waste Products of Agriculture -- Their Utilization as Humus" by Sir Albert Howard and Yeshwant D. Wad, Oxford University Press, London, 1931
Where Howard's famous An Agricultural Testament (below) charts a new path for sustainable agriculture, founding the organic movement at one stroke, this first book is more a practical guide to making compost: how the Indore composting system which was at the foundation of the new movement was developed, and why. Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

"An Agricultural Testament" by Sir Albert Howard, Oxford University Press, 1940.
This is the book that started the organic farming and gardening revolution, the result of Howard's 25 years of research at Indore in India. The essence of organics is brilliantly encapsulated in the Introduction, which begins: "The maintenance of the fertility of the soil is the first condition of any permanent system of agriculture." Read on! Full explanation of the Indore composting process and its application. Excellent on the relationship between soil, food and health. Full text online at the Journey to Forever **Small Farms Library**.

"Farming and Gardening for Health or Disease (The Soil and Health)" by Sir Albert Howard, Faber and Faber, London, 1945, Devin-Adair 1947, Schocken 1972
This is Howard's follow-up to An Agricultural Testament, extending its themes and serving as a guide to the new organic farming movement as it unfolded -- and encountered opposition from the chemical farming lobby and the type of agricultural scientists Howard referred to as "laboratory hermits". Together, the two books provide a clear understanding of what health is and how it works.
Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

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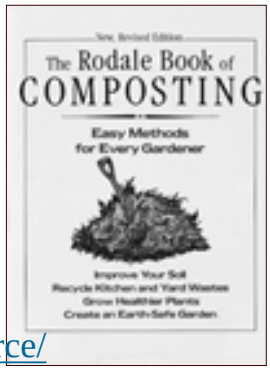
See a **review** of Albert Howard's work, plus a short bibliography and links to his major works and some of his published papers, at the Journey to Forever **Small Farms Library**.

"Pay Dirt -- Farming & Gardening with Composts" by J.I. Rodale, with an introduction by Sir Albert Howard, Devin-Adair, 1946
Inspired by the work of Albert Howard, J.I. Rodale bought a farm, founded Organic Gardening Magazine, as well as Rodale Publishing, worked tirelessly to introduce organic farming to the US, and wrote this book. A good wrap-up of the subject. Full text online at the Journey to Forever **Small Farms Library**.

General composting



"Rodale Book of Composting: Easy Methods for Every Gardener" by Deborah L. Martin and Grace Gershuny, Rodale Press, ISBN 0878579915, 1992
Composting is at the core of organic growing, and this encyclopaedia is Rodale's distillation of the subject in an easily accessible and readable form. From Rodale Store: http://WWW.rodalestore.com/webapp/commerce/servlet/ProductDisplay?prrfnbr=13100&merchant_rn=15336

"The Rodale Guide to Composting" by Jerry Minnich and Marjorie Hunt, Rodale Press, Emmaus, Pennsylvania, 1979
This is the previous version of the composting encyclopaedia, a complete survey of the alchemy of composting at home, on the farm, and in municipalities. If you can get it, this is the best of the many versions and rewritings the book has been through.

Rodale's Organic Gardening and Farming magazine was at a high point when Minnich was a senior editor. Later it split in two, Organic Gardening, and Organic Farming. We don't know what happened to Organic Farming.

The **manure fork** is the indispensible tool for composters -- ideal for mixing the ingredients, scooping it all into the box, scooping it out again later, breaking it up, fluffing it out, turning it, scattering it over the growing beds. From A.M. Leonard.
http://www.amleo.com/help-desk/item.php?0445

Cornell Composting -- extensive composting resources from Cornell University, including Composting in Schools, good set of resources and references, science and engineering of composting.
http://www.cfe.cornell.edu/compost/Composting_homepage.html

RotWeb -- How to compost your yard and kitchen wastes at home. Basic information about home composting -- introduction, how-to guide, ingredients, materials to avoid and why, different compost bin systems, composting resources on the Net, demonstration sites, teacher resources, report on backyard composting programs.
http://www.a-horizon.com/compost/compost_menu.html

The Compost Resource Page -- excellent composting site. "Studies have shown that home composting can divert an average of 700 lbs. of material per household per year from the waste stream." Detailed overview, good resources on home composting and vermicomposting, also composting toilets, and Home Composting Forum. Even a Compost Poetry Corner!
http://www.oldgrowth.org/compost/

The Master Composter site -- for home composting: build a pile, compost information, and local composting programs. Everything you could want to know about making and using compost.
http://www.mastercomposter.com/

Backyard Composting, by Craig Cogger, Ph.D., Washington State University Cooperative Extension Soil Scientist, and Dan M. Sullivan, Ph.D., Associate Professor, Department of Crop and Soil Science, Oregon State University. Useful 8-page how-to,

and why-to. Materials to use, hot vs cold composting, how to make compost, and more. Acrobat file, 56kb: http://cru.cahe.wsu.edu/CEPublications/eb1784/eb1784.pdf

Soil, Compost and Mulch Forum at Gardenweb. This forum is for the discussion of all aspects of soil -- including topics like creating a healthy, balanced soil, methods of composting and using mulches effectively. Active forum, lots of threads. http://www.gardenweb.com/forums/soil/

See also **Humanure**

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Vermicomposting

Composting indoors

Outdoors or indoors, anyone can make compost. If you don't have a garden, a small space in the garage will do, or on the balcony, or even under the kitchen sink.

Composting your kitchen scraps helps the environment by reducing the amount of garbage you produce, saving landfill space, and gives you a supply of clean organic soil to grow your own healthy vegetables and herbs -- and you don't need a garden for that either (see **No ground? Use containers**).

There are two ways of doing it:

Aerobic composting, the kind gardeners make: see the other pages in this section to understand what compost is and how to make it. Indoor composting is the same, only on a smaller scale.

Vermicomposting, using red wriggler earthworms -- see **Vermicomposting** for information on indoor worm composting systems. Don't be put off -- it's clean, nuisance-free and hygienic, and many people do it: worm-compost boxes have even been used as coffee-tables!

This section deals with making aerobic compost indoors.

Think small

Composters (including us) advise gardeners to use bins or boxes with a capacity of at least 10 cubic feet: that's equivalent to a 24x24-inch box 30" high, or a 24"-diameter tub 36" high.

These are too big for a household with no garden, and therefore no supply of garden wastes. So what is the minimum bulk?

We've made hot compost in a 10-gallon box rather than 10 cubic feet -- only one-sixth as much. Filled all at once, it got very hot, and was ready in two weeks. It's a bit different when the ingredients come in dribs and drabs instead of all at once, as they do from a kitchen, but you can make successful compost in a small container.

Actually you'll need two containers -- when the first one's full and processing, you start filling the second one, and by the time

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that's full, the compost in the first one's ready for use and can be emptied out.

A smallish (10-20 gallons) plastic or galvanized iron garbage can with a lid will do. Drill 10 or 12 holes in the bottom with a 3/8-inch bit, find a tray to stand it in, and put a couple of 1/2-inch slats under it for aeration.

A 15x15x15-inch wooden box made of 1/2-inch ply (untreated) will also do well. So will a 20x20x20-inch box. Again, drill holes in the bottom and stand it in a tray with slats under it to allow an air supply, and put a hinged lid on it. Treat it inside and out with vegetable oil.

Filling the bin

Use uncooked fruit and vegetables, no meat, fish, dairy, or oils -- at least at first. Once you're more experienced you can decide this for yourself.

By themselves, kitchen scraps are too wet to compost -- the moisture content averages 85%, and compost should be not more than 65%. So you need dry bedding to mix it with. This can be straw, dead leaves, strips of newspaper (avoid colored inks and glossy paper), cardboard or cartons, sphagnum **peat moss**, **coconut coir**, or a mixture. You can also use some sawdust (from non-treated wood) -- mix it with other bedding materials. Keep a bucket of bedding handy by your bin. Also keep a coffee-tin full of ordinary soil next to the bucket, and some wood ash is useful.

First, put a few inches of dry bedding in the bottom of the container. Scatter the daily supply of kitchen scraps on top, and cover the scraps with about the same amount of bedding, or a little more. Scatter some soil on top, and a little lime or wood ash. Keep going until it's full.

Mix the contents up every couple of weeks with a compost poker or compost aerator: buy one, or improvise.

Compost Aerator mixes and aerates your compost -- the two hinged wings fold back to plunge deep into the pile, then open to 7" to churn the material, creating new air passages. From Gardener's Supply Company (Item #31-326):

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Problems

You shouldn't have any, but if it starts leaking liquid into the tray, use more dry bedding and mix it up with the aerator. If it starts to smell, again, use more dry bedding and give it a good working over with the compost aerator, then more bedding on top and a little more soil.

Resources

"Real Dirt: The Composting Guide to Backyard, Balcony & Apartment Composting" by Lorraine Johnson and Mark Cullen, Penguin Books of Canada, 1992, ISBN 0140159614
Whether you live in a house or an apartment, in the city, suburbs, or the country, composting is the ultimate way to achieve a greener garden and contribute to a cleaner planet. For the veteran composter or the absolute beginner, this no-nonsense, inspirational guide ensures successful composting. Lorraine Johnson and Mark Cullen are both seasoned Canadian gardening writers. From Chapters.ca:
http://www.chapters.ca/books/details/default.asp?UID= 009768DBDC0111D383BB00508B629EDB&WSID= 1402009768DCDC0111D383BB00508B62&AFFID= 103667&ISBN=0140159614

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Vermicomposting

Vermicomposting uses earthworms to turn organic wastes into very high quality compost. This is probably the best way of composting kitchen wastes. Adding small amounts of wet kitchen scraps to a large compost pile in the garden day by day can disrupt the decomposition process so that the compost is never really done. But it works just fine with vermicomposting.

Many gardeners use vermicomposting systems for all their garden and kitchen wastes, many more use both types of composting, and thousands of households without gardens use neat and unobtrusive worm boxes indoors to compost their kitchen scraps (as well as newspapers and cardboard boxes), reducing their garbage by up to a third and providing their own organic soil for pot plants and container gardens on balconies and roofs to grow their own healthy food.

See **"Friend Earthworm: Practical Application of a Lifetime Study of Habits of the Most Important Animal in the World"** by George Sheffield Oliver, 1941 -- one of the all-time classics on the earthworm. Dr Oliver was one of the first to harness the earthworm to the needs of the farmer and gardener, making highly fertile topsoil for optimum crop growth, and producing a constant supply of cheap, high-grade, live protein to feed poultry. He devised simple yet elegant and effective systems to bring costs and labour down and productivity up to help struggling farmers make ends meet. Oliver had an observant and critical eye and understood Nature's round. His ideas on the nature of modern food and health (or the lack of it) are only now being confirmed, half a century later. A delightful book. Full text online at the Journey to Forever **Small Farms Library**. Plus "My Grandfather's Earthworm Farm", "Eve Balfour on Earthworms", "Albert Howard on Earthworms", "The Housefly" by Roy Hartenstein.

Vermicompost and plants

Vermicompost consists mostly of worm casts (poop) plus some decayed organic matter. In ideal conditions worms can eat at least their own weight of organic matter in a day. In fact it seems they don't actually eat it -- they consume it, sure enough, but

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Worm casts -- the best soil there is

what they derive their nourishment from is all the micro-organisms that are really eating it. And yet -- mystery! -- their casts contain eight times as many micro-organisms as their feed! And these are the micro-organisms that best favour healthy plant growth. And the casts don't contain any disease pathogens -- pathogenic bacteria are reliably killed in the worms' gut. This is one of the great benefits of vermicomposting.

Chinese spinach seedlings grown with (from left) chemical fertilizer, powdered horse manure, vermicompost, and nothing.

Worm casts also contain five times more nitrogen, seven times more phosphorus, and 11 times more potassium than ordinary soil, the main minerals needed for plant growth, but the large numbers of beneficial soil micro-organisms in worm casts have at least as much to do with it. The casts are also rich in humic acids, which condition the soil, have a perfect pH balance, and contain plant growth factors similar to those found in seaweed. There's nothing better to put in your garden!

> -- "Worms seem to be the great promoters of vegetation, which would proceed but lamely without them, by boring, perforating, and loosening the soil, and rendering it pervious to rains and the fibres of plants, by drawing straws and stalks of leaves and twigs into it, and, most of all, by throwing up such infinite numbers of lumps of earth called worm-casts, which, being their excrement, is a fine manure for grain or grass." -- The Rev. Gilbert White of Selborne, 1777

> -- "All the fertile areas of this planet have at least once passed through the bodies of earthworms." -- Charles Darwin, "The Formation of Vegetable Mould through the Action of Worms with Observations on their Habits", John Murray, London, 1881

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The worms

These are not the usual big burrowing earthworms that live in garden soil. Called red worms, tiger worms, brandlings, angle worms, manure worms, or red wrigglers, they occupy a different ecological niche, living near the surface where there are high concentrations of organic matter, such as on pastures or in leaf mould, or under compost piles.

Two breeds are used in vermicomposting: *Eisenia foetida* or *Lumbricus rubellas*. Many garden centres now supply them, and in most countries they can be bought by mail order from worm farms. Some sellers advertise special high-performance breeds or specially developed hybrids, but don't believe them -- they'll be one of these two breeds. There's no such thing as a hybrid worm.

You'll need 1,000 worms (1 lb) to start a worm box, maybe twice that if you want to process your garden wastes too -- they breed very fast in the right conditions, but starting with more will give the system a good start.

Breeding

Worm populations double each month. In ideal conditions they can reproduce much faster than that: 1 lb of worms can increase to 1,000 lbs (one million worms) in a year, but in working conditions 1 lb will produce a surplus of 35 lbs in a year, because hatchlings and capsules (cocoons or eggs) are usually lost when the vermicompost is harvested.

Mature redworms make two or three capsules a week, each producing two or three hatchlings after about three weeks. The hatchlings are tiny white threads about half an inch long, but they grow fast, reaching sexual maturity in four to six weeks and making their own capsules. Three months later they're grandparents!

This rapid breeding rate means the worm population easily adjusts to conditions in the worm box according to the feed supply and the proportion of worm casts to feed and bedding -- their casts are slightly toxic to them, and as the box gets "full" they'll either leave, if there's anywhere for them to go, or they'll die off.

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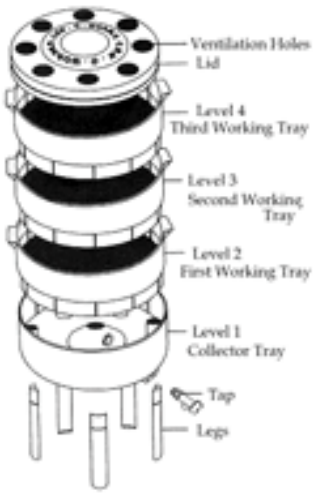
This is an important consideration -- if you only want the vermicompost for the garden it doesn't much matter if the worms die off, as long as you've kept some aside to set a new box going. It also makes it easier to harvest the castings, and you'll have a higher proportion of pure castings.

But if you want to produce excess worms as well, to extend your worm system, for sale as fishing bait, or to feed to poultry or fish (they really thrive on wormfeed), you'll need to separate them from the vermicompost before the proportion of castings gets too high. See below, **Harvesting**.

Worm boxes

This section mainly applies to using worms to compost kitchen wastes. For garden wastes, the same basic principles apply, with a few cautions: see below, **Garden wastes**.

There's a good range of specialized worm composting units that you can buy: Can-O-Worms, Worm Factory, Worm-a-way, Eliminator, Worm-A-Roo, Tiger Wormery and others -- you'll find details at **Vermicomposting resources**.



Reln's three-tray Can-O-Worms

Or you can easily build one yourself. In fact many people advise it, saying that wood is better than plastic -- the commercial models are usually made of plastic, which doesn't "breathe", while wood is porous and allows for better ventilation.

Dimensions

The size of the unit should be geared to your household's production of kitchen scraps.

One or two people usually produce about 4 lb of food waste a week: use a 2ft x 2ft box 8" deep. For three people make it 12" deep, for more, 2ft x 3ft x 12" deep -- or two 2-person boxes might be better, because bigger boxes can be too heavy to move when they're full.

Use exterior-grade 1/2" plywood. Don't use chemically-treated

wood. Treat the wood with a non-toxic wood preservative, or paint it with vegetable oil, or linseed oil. Use galvanized nails. Drill at least a dozen 1/2" holes in the bottom for aeration, and arrange it so that two opposite sides are half-an-inch deeper so that the bottom stands off the ground. Stand the box in a tray, because it will probably leak a bit.

Once filled, cover the surface with black plastic sheeting (a garbage bag) slightly smaller than the surface area: this will keep the moisture in, and the worms will work right up to the surface. If this makes it too wet, use a couple of newspapers instead. Make a lid for the box. Keep it anywhere convenient.

Bedding

Fill the box with moist bedding for the worms to burrow in and to bury the food scraps in. You need about 6 lb (dry weight) for a 2ft x 2ft x 8" box. Worms will eat the bedding as well as the food scraps, so you'll need to top it up in a few months.

Adding new bedding (Greater Vancouver Regional District)

Any inert, non-toxic, fluffy material that holds moisture and allows air to circulate will do. Don't use anything that will decompose too rapidly when you moisten it and get hot, like manure that's not aged enough or hay, especially alfalfa hay. Mixed bedding is better, but no need to be too complicated: 2/3 corrugated cardboard and 1/3 sphagnum **peat moss** or **coco peat moss** is a good mixture, or sphagnum peat moss, shredded leaves and sawdust; or just cardboard and/or newspaper.

- Cardboard cartons (corrugated): cut them up into strips an inch wide and a few inches long. Don't use the shredded cardboard sold for insulation because it's treated with toxic chemicals.
- Newspaper: tear it into 1" strips -- it's easy to tear with the grain. Black ink is non-toxic, avoid glossy paper.
- Shredded computer paper.
- Autumn leaves: spread them thickly in the driveway and drive over them with the car a few times to break them up, or shred them with a lawnmower. Or moisten them, sprinkle some lime, ground limestone or wood ash over

them and bundle them up in a garbage bag, tie the top closed, and in a few months they'll have broken down enough to be excellent worm bedding. Or just use them as is, though it'll take a bit longer for the worms to break them down.

- Aged manure, or composted manure: cow, horse, rabbit.
- Sphagnum **peat moss**: use Canadian peat moss, soak it in water for 24 hours, squeeze it out and sprinkle some lime on it.
- **Coco peat moss** or coir (coconut fibre): comes in compressed bricks, soak in water and they swell up -- no need to add lime.
- Chopped-up straw or other dead plant material, spoiled hay, yard clippings, dried grass clippings: any plant material "aged" beyond the green stage.
- Sawdust, wood shavings: from non-aromatic wood, avoid treated wood, about a quarter to a third of the bedding mixture.

Add a couple of handsful of soil or sand -- it helps the worms grind up the food in their gizzards. Sprinkle a bit of lime, ground limestone or wood ash over the bedding (not too much!). Ground limestone is best.

Worm bedding and feed can be wetter than compost material: 75%, compared with 65% maximum for compost. Dry bedding usually needs a bit less than three times its weight in water (a pint of water weighs a pound, a litre weighs a kilogram).

Once it's all suitably shredded, mixed and moist, put it in the box and add the worms (about 1lb -- 1,000 worms). Leave it for two or three days to let the worms settle in before adding wastes.

Feeding

No metal, foil, or plastic. Use vegetable and fruit scraps, coffee grounds (including paper filters), tea bags (remove the staple), eggshells (best dried and crushed first, then sprinkled over the surface), stale bread, houseplant trimmings. Chop up big chunks. Some people advise against citrus, and also onion and garlic, others use them: try small quantities first. Not too much vegetable oil, be cautious at first with dairy products, meat and fish -- small amounts chopped fine, well-dispersed and well-covered with bedding should be okay. Broken chicken bones are okay, bigger bones won't break down but shouldn't

cause problems either -- they'll be picked clean.

It's best to collect food scraps in a small bucket with a lid and add them to the worm box every couple of days (or more often in hot weather -- don't let it go rotten). Bury them in the bedding in a corner of the box. Next time, bury the new scraps near the first scraps. You can have about nine burial sites in a 2x2ft box: by the time you've used the ninth one, you can go back to the first site again, the worms will have cleared it.

You'll be surprised how much feed you can put in that box -- the worms and micro-organisms reduce it more than you'd think possible.

The box will need emptying every 3-6 months.

Best tool for burying feed: a three-pronged hand-cultivator (hand-fork).

Harvesting

If it's mainly the worm casts you want to use as garden compost, any of the following methods will do. If you value production of worms as well as casts, use the light separation method or a wire mesh screen.

Some hassle -- light separation

Dump the finished material from the box onto a big piece of plastic (eg, an opened-out garbage bag) on the floor or on a table under a 100W light, or outside in the sun.

Form it into eight or nine mounds. Worms are sensitive to light and immediately burrow beneath the surface. Wait a few minutes, and meanwhile put fresh bedding in the box.

Keith harvests a worm box

A handbrush and dustpan are useful for this. Lightly brush the top off each mound until the worms are revealed, then wait for them to burrow deeper and do it again. Eventually you're left with a squirming mass of worms all trying to get under each other to avoid the light. Quickly put

them in the new bedding in the box with a fresh supply of feed.

Worm spaghetti!

This leaves you with a rich harvest of worm castings and a lot of capsules, which you lose (the hatchlings won't survive in garden soil), but the worms in the bin will soon replace them. Store the castings for a week or two before using them in the garden.

Kids love this -- if you have any tame children around you can usually talk them into doing it for you.

Less hassle -- sideways separation

Shift all the material in the box to one side and fill the other side with fresh bedding; put your kitchen scraps and feed only in the fresh bedding side. In the next week or two the worms will migrate from the finished vermicompost into the fresh bedding. In the meantime the capsules will hatch and most of the hatchlings will also move across, so you won't lose them, which is an advantage over the dump-and-sort method.

Even less hassle -- vertical separation

Get a piece of nylon or mesh window screening a bit bigger than the surface of the box and lay it flat on the surface of the vermicompost. It should be big enough to flatten against the sides and leave some overlap at the top. Fill the box up with fresh bedding on top of the screen and continue feeding it with kitchen scraps. The worms will migrate up through the screen into the new bedding as the food runs out below.

When the top part is ready for harvesting, use the overlap to lift the screen from the box, vermicompost, worms and all. Set it aside and empty the box -- it will have a very high concentration of worm castings and few if any worms, hatchlings or capsules.

Dump the wormy material that was on top of the screen into the bottom of the box and put the screen back on top of it, with fresh bedding on top of the screen.

Check the condition of the screen each time you empty the box, and replace it before it gets rotten enough to rip just as you're removing it, spilling everything back into the box.

No hassle

This method will give you lots of trouble-free castings, but no extra worms. Go on feeding kitchen scraps to the box for up to four months, and then start a second box -- prime it with fresh bedding and a supply of worms from the first box. Just leave the first box until the second box is full, by which time the first box will contain a very high proportion of fine castings, and very few worms.

To make sure there are enough worms for both boxes, you can prepare the second box about a month earlier, adding some worms to it every time you add feed to the first box.

Screening

The vermicompost might need screening, especially if you've used rough stuff (sticks etc.) in the bedding that takes time to break down. A circular gardener's sieve with a 3/16" mesh will work best. Try to get one with stainless steel mesh, it'll do the job much quicker, the worm castings won't stick to the mesh, and it won't rust.

This is also a good way of separating the worms from finished vermicompost, though capsules and hatchlings are lost.

Problems

Flies and smells -- there shouldn't be any, but sometimes it happens. Worm casts have a pleasant, earthy smell, like forest soil. If the worm bin starts to smell, there's too much feed in it, more than the worms can process -- you've overloaded the system. Stop feeding the worms, add more dry bedding, a little sprinkled lime, and stir the bin with the hand cultivator (hand-fork). Repeat until the smell vanishes.

Fruit flies (actually vinegar flies) can get into the box, but they do no harm. Lots of them mean too much feed -- cut down the feeding rate and cover the surface with a damp newspaper.

The bin can also have an influx of soldier fly maggots, up to an inch long (they're a favourite with fishermen). Vinegar fly larvae are much smaller. Actually the maggots benefit the composting process, but if you don't like them, add more bedding and lime and stir as above, or put a chunk of bread soaked in milk on the surface. In a couple of days it will be infested with larvae; take it out and get rid of it (give it to a fisherman or a chicken).

Garden wastes

Outdoor boxes can be bigger. The simplest way of all is a 12-inch-deep trench in the soil about 2ft wide or more with 8" of bedding and/or compost to put the worms in. Red worms can't survive long in ordinary garden soil so they won't crawl away. Add garden wastes as they come, putting it in a different part of the trench each time, and cover with a sprinkling of soil and lime. Bury kitchen wastes at the bottom, under the garden wastes.

Fresh garden wastes might get hot, but the worms will have a place to escape to until it gets cool enough for them to handle.

To keep moles away, line the trench with 1/2" chicken wire or wire mesh.

Or make a four-sided wooden box with four 18" by 36" boards (or nail narrower planks together), treat it with vegetable oil or linseed oil, and stand it on a layer of bricks on top of the soil. Put 6" or so of bedding in the bottom and put the worms in it. Add wastes to the corners in succession. Shake the soil off clumped roots. Chop up big bits with the edge of a spade. Add more bedding as necessary. Bury kitchen scraps.

See **"Friend Earthworm: Practical Application of a Lifetime Study of Habits of the Most Important Animal in the World"** by George Sheffield Oliver for more information -- online at the Journey to Forever **Small Farms Library**.

Organic gardener and writer Steve Solomon describes another method using garbage cans in the vermicomposting section of his book "Organic Gardener's Composting", online at the Soil and Health Library:
http://www.soilandhealth.org/

Using vermicompost

Use like compost -- dig it lightly into the topsoil around your plants. In composting growing beds or preparing new beds, vermicompost generally goes about twice as far as ordinary (aerobic) compost, so use half as much. But each garden is different (and so is each gardener!) -- some people have good results simply dumping large amounts of the stuff on top of their beds (6" a year in one case), others with very little.

Vermicompost gives seedlings a really good start in life.

In pots and containers, don't use pure vermicompost. About 25% of the growing mixture seems to be about ideal, but experiment -- it might vary according to what you mix it with.

You can also use vermicompost to make "compost tea" liquid fertilizer. Mix two tablespoons of vermicompost with a litre of water and let it stand for a day, shaking it occasionally, then sprinkle under the plants. One-litre drinking water bottles make good sprinklers: drill a few small-diameter holes in the lid, point and squeeze.

For transplants, especially bare-root transplants, spray them with an even more dilute solution of "tea", or stand them in it for awhile -- it'll help to prevent transplant shock. (Liquid seaweed solution is excellent for this.)

Don't let the vermicompost dry out before using it -- it loses a lot of its value and resists wetting. If you store it, don't use an airtight container. It will keep for a year or more.

See **Vermicomposting resources** for more information.

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Books

"The Formation of Vegetable Mould through the Action of Worms with Observations on their Habits" by Charles Darwin, John Murray, London, 1881; Faber and Faber, London, 1945, with an Introduction by Sir Albert Howard; 1976, ISBN 0916302067

A classic of ecology. "All the fertile areas of this planet have at least once passed through the bodies of earthworms." Darwin had a much higher opinion of this book than of his "Origin of Species", which he had to be persuaded to write. He experimented with worms for more than 40 years.

Earthworms are slowly burying Stonehenge, says Darwin: Section through a fallen Druidical stone, showing how much it had sunk (nearly 12")

This is one of his conclusions, following a most elegant series of experiments: "One alternative alone is left, namely, that worms, although standing low in the scale of organization, possess some degree of intelligence." Darwin proved that worms make intelligent choices! This book is a rare delight. From Vermico: http://www.vermico.com/books.html

Full text online at the Soil and Health Library: http://www.soilandhealth.org/

"Friend Earthworm: Practical Application of a Lifetime Study of Habits of the Most Important Animal in the World" by George Sheffield Oliver, 1941 -- one of the all-time classics on the earthworm. Dr Oliver was one of the first to harness the earthworm to the needs of the farmer and gardener, making highly fertile topsoil for optimum crop growth, and producing a constant supply of cheap, high-grade, live protein to feed poultry. He devised simple yet elegant and effective systems to bring costs and labour down and productivity up to help struggling farmers make ends meet. Oliver had an observant and critical eye and understood Nature's round. His ideas on the nature of modern food and health (or the lack of it) are only now being confirmed, half a century later. A delightful book. Full text online at the Journey to Forever **Small Farms Library**. Plus

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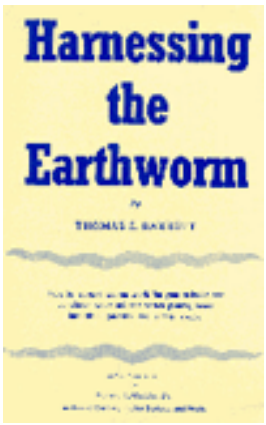
"My Grandfather's Earthworm Farm", "Eve Balfour on Earthworms", "Albert Howard on Earthworms", "The Housefly" by Roy Hartenstein.



"Harnessing the Earthworm" by Dr. Thomas J. Barrett, Humphries, 1947, with an Introduction by Eve Balfour; Wedgewood Press, Boston, 1959; Bookworm Pub Co, ISBN 0916302091
"A practical inquiry into soil building, soil conditions, and plant nutrition through the action of earthworms, with instruction for the intensive propagation and use of domesticated earthworms in biological soil building." Well-researched, well-written, pioneering book on vermicomposting, very positive outlook, a refreshing read. Includes Dr George Sheffield Oliver's famous story "My Grandfather's Earthworm Farm" -- inspiring! Facts, figures and illustrations, details of Barrett's Earthmaster Culture Bed. From Vermico:
http://www.vermico.com/books.html
From City Knowledge.com:
http://www.cityknowledge.com/earthworms/order_form.html

"The Earthworm Book: How to Raise and Use Earthworms for Your Farm and Garden" by Jerry Minnich, Rodale Press, Emmaus, 1977, ISBN 0878571930
Hard to find -- this is Rodale's worm encyclopaedia, a thorough survey of the subject.

"Worms Eat My Garbage" by Mary Appelhof, Flower Press, Kalamazoo, Michigan, 1982
A quick, easy read, simple and positive guide to vermicomposting by biologist Mary Appelhof, aka "Worm Woman", who's been feeding her garbage to worms for more than 20 years.
http://www.wormwoman.com/

Mary Appelhof's Worm-a-way bin

"Biology of Earthworms" by C.A. Edwards and J.R. Lofty, 1972, ISBN 0916302202
This is the classic first edition of Dr. Clive Edwards' textbook on the biology and habits of earthworms. "No previous book has attempted to review all aspects of the biology, morphology,

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physiology, taxonomy, and ecology of earthworms, and we hope that the present volume may help to fill this need." Photos, charts, graphs, tables, and diagrams.
http://www.vermico.com/books.html

"Biology and Ecology of Earthworms" by C.A. Edwards and P.J. Bohlen, Chapman & Hall, 1996, ISBN 0412561603
The third edition of this basic textbook on earthworms reviews all aspects of earthworm biology and ecology; updated throughout with extensive additions. Expanded treatment of earthworm community ecology, interactions between earthworms and microorganisms, and the importance of earthworms in environmental management and their use in organic waste management. 70-page bibliography. Comprehensive. From Vermico:
http://www.vermico.com/books.html

"Organic Gardener's Composting" by Steve Solomon, 1993, Van Patten, Oregon
Good all-round advice for beginning vermicomposters: see the Vermicomposting section. Two subjects in one book: a basic, how-to-make-compost book in Part One; and how to make really good compost in Part Two, along with an analysis of the nutritional consequences of soil fertility management choices. Online:
http://www.soilandhealth.org/

Online resources

Worm Digest -- online articles, worm forum, back issues, library, large selection of books, site search, bins, harvesting, suppliers, product reviews, everything about worms and vermicomposting here.
http://www.wormdigest.org/

Vermicomposting at the excellent Compost Resource Page. The **Earthworm FAQ** is a must-read (Reprinted from Green Hut):
http://www.oldgrowth.org/compost/wormfaq.html
The **Vermicomposting FORUM** -- or several Forums: General Info, Beginners Only, Commercial/Large-Scale, Bin Designs, Education, and an Archives with more than 3,000 messages and a search engine.
http://www.oldgrowth.org/compost/forum_vermi/index.html

Worm Composting Bin -- Compost Units Series from the

Education resources on the Web
Children's poetry

Contact us

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Homepage
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Handmade Projects
Ichijima
Japan

Cooperative Extension Service, University of Arkansas. Suitable for apartment buildings or other homes with no yard space. The worms stay in the bin and eat household scraps, no smells. Made from a single piece of 4x8ft 1/2" plywood. Full plans and details, instructions. Building a worm composting bin, adding the worms, adding your wastes, maintaining your worm composting bin.
http://www.dnr.state.mo.us/deq/swmp/worm1.htm

Lots of useful and interesting stuff about worms at **The Burrow**.
http://gnv.fdt.net/~windle/
The best information on bedding -- everything you need to know here: Introduction, Peat Moss, Bog Soil, Newsprint, Machine-Shredded Paper, Cardboard (cardboard's his favourite):
http://gnv.fdt.net/~windle/1bedding.htm

Global worming -- worm composting books, videos, worm bins, red worms, educational resources from "Worm Woman" Mary Appelhof.
http://www.wormwoman.com/

Worms: The New "Bug" For The New Millenium by City Farmer, Canada's Office of Urban Agriculture. "Worms make great pets. They're quiet. And all they do is eat and reproduce all day long." Good introduction to vermicomposting in cities based on City Farmer's years of experience in encouraging and educating citizens of Vancouver. Links to good vermicomposting resources on the web.
http://www.cityfarmer.org/y2kworms.html#y2kworms

City Farmer's QuickTime movie on how to harvest your worm bin
http://www.cityfarmer.org/moviewormharvest.html#movie

"Black Gold" at City Farmer: "In this day and age, you can get overwhelmed by all that is wrong with the world. But we believe in the power of one," says Spring Gillard, one of the wormshop instructors at City Farmer's Compost Demonstration Garden. "One worm eats its own body weight in food every day. By putting a worm bin on your balcony, or under your kitchen sink, you are demonstrating how much one person can do. After all, you're diverting at least a third of your garbage from the landfill. And you're setting an example that can ripple forth into the community."
http://www.cityfarmer.org/blackgold75.html

A huge **worms FAQ** at Agriculture & Agri-Food Canada's "Frequently Asked Questions About Earthworms" -- more like every imaginable question. Comprehensive.
http://res2.agr.ca/london/pmrc/english/faq/earthwor.html

"An Introduction To Raising Earthworms -- Everything You Wanted To Know About Earthworms But Were Afraid To Ask" Or "How To Make Money Raising Earthworms" -- also What Is A Domesticated Earthworm? -- How to Raise Earthworms -- Construction Of Beds Or Pits -- Earthworms For Soil Improvement, and more.
http://www.cityknowledge.com/earthworms/intro.html

The 45-litre (10-gallon) **TigerWormery** is made from 100% recycled newspapers and it's porous so excess moisture evaporates. Clean and compact, perfect for apartments. From Recycle Works in England.
http://www.recycleworks.co.uk/pages/wormery.htm

Composting with Redworms, by Joyce Jimerson, Master Composter/Recycler Program Manager at Washington State University. The solution for apartment dwellers with no space for a compost pile. "Kitchen wastes can be converted to a rich humus with the help of redworms. Children find worms fascinating. They are very well behaved 'pets,' and also help with household chores!" Small-space worm composting in a nutshell.
http://whatcom.wsu.edu/ag/compost/Redwormsedit.htm

Cheap and easy worm bin -- simple system for indoors, using two plastic storage boxes. Instructions and photographs, from Cooperative Extension, Washington State University.
http://whatcom.wsu.edu/ag/compost/Easywormbin.htm

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Humanure

The most wasteful piece of equipment ever devised -- the flush toilet.

> **"Nearly a third of all household drinking water in the US is used to flush toilets" -- Joseph Jenkins, "The Humanure Handbook"**
>
> **"The function of all organic matter, animal and vegetable, is to maintain the fertility of the soil" -- J.C. Wylie, "The Wastes of Civilization"**

Journey to Forever founder member Keith Addison composted humanure when he ran a smallholding in England in the late 1980s. "It was completely innocuous," he says. "One day the landlord and his wife visited us from the Big House. We all had tea on the lawn, a few feet away from a big compost unit with a lot of humanure in it. They didn't notice anything -- her ladyship even spent a while leaning against it while we were chatting. The compost temperature in that unit went up to about 70 degrees Centigrade, so it was completely sanitized. It made good compost."

Foundation work

The Moule Earth Closet

Moule's Patent Earth Commode Pat. 1869 -- Mark Henderson http://www.jldr.com/ohcloset.html

In 1859 the Rev Henry Moule of Dorset in England decided the family cess-pit was a foul abomination, had it filled in, and told his family to use buckets, the contents to be emptied and buried in trenches in the garden -- where, within weeks, "not a trace of it could be discovered". What could soon be discovered was a "luxuriant growth of vegetables in my garden" -- and that dry surface earth, not water, was the place for "offensive matters". He wrote a pamphlet on it: "National health and wealth, instead of the disease, nuisance, expense, and waste, caused by cess-pools and water-drainage", and became a tireless campaigner for his by-now patented Moule Earth Closet (No 1316, 1860) -- wondrous Victorian-style machines which "flushed" dry earth via a lever, or automatically when you stood up, with luxury models in mahogany and oak. The soil could be dried and re-used up to seven times without offence or nuisance. It was a powerful fertilizer: a neighbouring farmer's swedes grew a third bigger when he used it instead of superphosphates. "Manure for the millions," Moule wrote in a letter to the cottage gardeners of England. Schools used them, and barracks, *The Lancet* wrote of them glowingly, even Queen Victoria had an earth closet (though of course she never had to use it...). But in the end the sheer mindless convenience of the water closet (flush toilet) won the battle -- though perhaps not yet the war.
http://www2.exnet.com/1996/01/15/science/science.html

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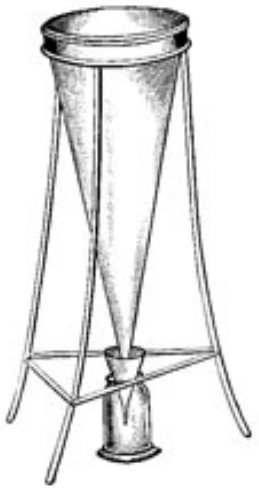
"Essays on Rural Hygiene" by George Vivian Poore, MD, second edition, 1894, Longmans, Green, London.



Poore's earth tests: earth in the funnel, urine in the top, water out the bottom

Dr. Poore called his book "Rural Hygiene" because "it is in the country alone that it is possible to be guided by scientific principles in our measures for the preservation of health and the prevention of disease. In cities the hygienic arrangements are the results of expediency rather than principle". He quoted Cowper: "God made the country and man made the town." In the country, "the householder is able to make his sanitation complete, and to finish, on his own premises, and to his own profit, that 'circulation of organic matter' which is the law of nature, and the only true basis upon which the science of sanitation can possibly stand firm". His solution involved the daily use of nightsoil in a highly successful system of horticulture developed over 20 years -- in other words, he buried it, and then he raised crops on it. And he demonstrated it was hygienic. "The gardener and the farmer are the right-hand men of the sanitarian." Indeed. The later development of the Indore composting system made these truths just as applicable to the town.

"Soil Fertility and Sewage -- An account of Pioneer Work in South Africa in the Disposal of Town Wastes" by J.P.J. van Vuren, with a foreword by Lady Howard, 1949, Faber & Faber, London.
A detailed and scientific survey of the results of 10 years' labour applying the Indore composting system to recycling town wastes and nightsoil in South Africa. By the time this book was published half a million cubic yards of urban compost a year were being made in South Africa, and being sold at a healthy profit. Van Vuren never loses sight of the ultimate purpose: "Cities and towns have for too many centuries been veritable graveyards where, in most instances, only the charred remains of the youth and life of many a soil --- and ultimately civilization -- lie buried and forgotten. It is our duty, as well as our privilege, to ensure that such destructive, almost criminal, practises are no longer allowed to continue." The book is "Dedicated to the first ten inches of soil."

For an introduction to Van Vuren's pioneering work, see **The Utilization of Municipal Wastes in South Africa** (full text online at Journey to Forever) by J.P.J. van Vuren, Appendix C in "Farming and Gardening for Health or Disease (The Soil and Health)" by Sir Albert Howard.

Sir Albert Howard always looked to the forest for the perfect model of nature's methods: "The forest suggests the basic principle underlying the correct disposal of town and village wastes in the tropics. The residues of the trees and of the animal life, met with in all woodlands, become mixed on the floor of the forest, and are converted into humus through the agency of fungi and bacteria. The process is sanitary throughout and there is no nuisance of any kind. Nature's method of dealing with forest wastes is to convert them into an essential manure for the trees by means of continuous oxidation. The manufacture of humus from agricultural and urban wastes by the Indore Process depends on the same principle." With techniques and successful applications, in **The Manufacture of Humus from the Wastes of the Town and the Village** (full text online at Journey to Forever), by Sir Albert Howard.

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Japan

"The Wastes of Civilization" by J.C. Wylie, 1959, Faber & Faber, London. This is a history of the wastefulness of man. It begins with the kitchen middens of Neolithic man and continues through the refuse-strewn streets and pest-ridden houses of mediaeval towns to the clean cities of today -- where we simply try to hide the wastes from view, and try to turn a blind eye to the nauseating dumps, polluted rivers and coastal waters, and the worn out soils which result. "The function of all organic matter, animal and vegetable, is to maintain the fertility of the soil," Wylie writes, and shows how it's to be done, economically and hygienically, through mechanized composting, solving the ancient problem at long last.

"Fertility from Town Wastes" by J.C. Wylie, with a Foreword by Sir Cedric Stanton Hicks, 1955, Faber & Faber, London
"A work of the greatest importance... it cannot be too highly recommended," said Mother Earth in its review of this book. The Spectator praised its "evocative literary quality" -- not something you expect to find in a book about garbage and toilets, but it's a good read. Intelligent and thorough treatment of the nature, value, treatment and disposal of organic and inorganic wastes, cleverly linked to soil fertility and food conservation problems. With work of this caliber done 50 years ago, along with that of Van Vuren and others, it makes you wonder what shred of an excuse the world's municipal and sanitation authorities, and all the other authorities, can offer for the trillions upon trillions of precious drinking water wasted on sewage, the pollution it causes, the huge areas of land devoted to landfills, the pollution that causes, and the continuing food scares, which relate straight back to the soil fertility problem. Answer? No excuse at all.

"Composting -- Sanitary Disposal and Reclamation of Organic Wastes" by Harold B. Gotaas, Professor of Sanitary Engineering, Department of Engineering, University of California, Berkeley, California, USA, 1956, World Health Organization, Geneva.

Composting nightsoil and city refuse in China in the late 1970s.

"Sanitary treatment of organic waste materials for the protection of health and preparation of wastes for utilization in agriculture are compatible," says Prof. Gotaas. This book discusses "the fundamental aspects of composting, which are the basis for satisfactory processes". Pioneering work was done on composting at Berkeley in the 1950s. Gotaas uses Howard's Indore composting system as the basis for dealing with the sanitary composting of wastes and nightsoil in cities, towns and villages, and on farms, using examples from around the world.

History of Plumbing in America
http://www.theplumber.com/usa.html

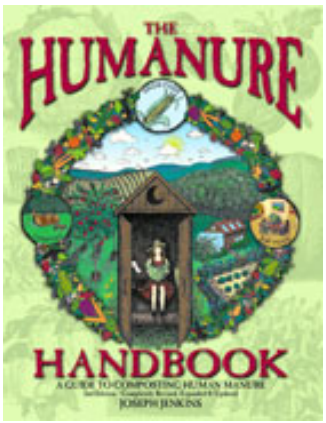
Modern developments

Composting toilet resources at The Compost Resource Page:
http://www.oldgrowth.org/compost/

City Farmer has extensive links and resources on Composting Toilets -- and

they use them on their city farm.
http://www.cityfarmer.org/comptoilet64.html#toilet

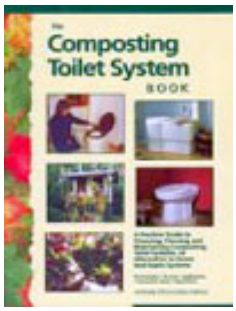
"The Humanure Handbook -- a Guide to Composting Human Manure" by Joseph Jenkins, 1999, 2nd Edition, Jenkins Publishing.



How-to manual on composting human manure. Jenkins is a humanure composting practitioner and organic gardener. Radical (as it needs to be): "Defecating in our drinking water is perhaps one of our culture's most curious, but least talked about, habits." Practical and well researched guide, covers the decomposition process, toilet design, pathogens, use of organic products, and much more. It's a good read too. Includes low-tech systems with plans for a sawdust toilet, using no electricity and minimal water, coupled with thermophilic (hot) composting to destroy pathogens and produce a valuable compost soil conditioner. Illustrated, tables and charts, 304 pages.
http://www.jenkinspublishing.com/
Online version:
http://www.weblife.org/humanure/

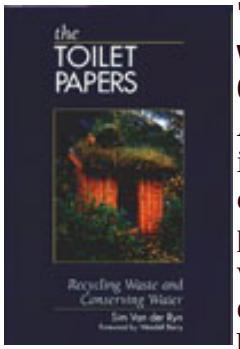
-- "Thermophilic microorganisms, such as bacteria and fungi, can create an environment in the compost which destroys disease organisms that can exist in humanure, converting humanure into a friendly, pleasant-smelling, humus safe for food gardens. Thermophilically [hot] composted humanure is entirely different from night soil. Perhaps it is better stated by the experts in the field: 'From a survey of the literature of night soil treatment, it can be clearly concluded that the only fail-safe night soil method which will assure effective and essentially total pathogen inactivation, including the most resistant helminths [intestinal worms] such as Ascaris [roundworm] eggs and all other bacterial and viral pathogens, is heat treatment to a temperature of 55 to 60 deg C for several hours.' The experts are specifically referring to the heat of the compost pile." -- Joseph Jenkins, "The Humanure Handbook"

How to make and use a simple **"sawdust" toilet**:
http://users.easystreet.com/ersson/sawdust.htm



"The Composting Toilet System Book: A Practical Guide to Choosing, Planning and Maintaining Composting Toilet Systems" by David Del Porto and Carol Steinfeld, 1999, Chelsea Green, ISBN: 0966678303
David Del Porto has sold and serviced thousands of composting toilet systems and has designed composting toilet and greywater systems for Greenpeace and for developing countries. Carol Steinfeld is a free-lance writer, editor and technology transfer specialist focusing on ecological resource solutions. She is co-founder of the Center for Ecological Pollution Prevention (CEPP). Descriptions of more than 40 systems, covers ready-made and home-built systems, wet and dry toilets, self-contained composters and central units. Features unsaturated aerobic systems, but also covers separation (black

and grey and shades of grey water) issues, dry and urine-separating toilets of various designs worldwide, greywater covered in depth, what plants to use to consume the water and nutrients, plus the composting process.
From the Center for Ecological Pollution Prevention (buying direct from the CEPP helps support their work):
http://www.cepp.cc/products.html#CTSBook



"The Toilet Papers: Recycling waste and conserving water" by Sim Van Der Ryn, 1995, Chelsea Green, ISBN: 0964471809
A classic back in print, with a forward by Wendell Berry -- informative and irreverent look at human waste through the centuries, and what options are available today. Homeowner plans for several types of dry toilets, compost privies and grey water systems. Van der Ryn is a former architect, sound and elegant designs. One of the favourite books of the back-to-the-land movement. From Chelsea Green:
http://www.chelseagreen.com/Shelter/ToiletPapers.htm

"Future Fertility: Transforming Human Waste Into Human Wealth" by John Beeby, 1995
"Despite all of the knowledge humankind has accumulated in the past 10,000 years, we still do not know fully how to use our urine and manure to fertilize our farmlands in a way that is simple and efficient, will not spread disease, and will benefit the soil. This knowledge is increasingly important as soils continue to lose the minerals and organic matter they need to remain fertile. Discovering how to utilize our waste as fertilizer is the challenge we must meet if our farmlands are to continue to provide us with food." Detailed and practical manual, describes established and innovative low-technology methods of safely and effectively recycling the nutrients in human waste, the principles behind the methods, and criteria to ensure human waste is processed safely and the fertility of the soil maintained. A must for those interested in transforming their waste into wealth in the future. From Bountiful Gardens:
http://www.bountifulgardens.org/growbiointensive-books.html#7

Compost toilets -- 5-page Technical Brief by Paul Calvert, based on his experience designing and building compost toilets in India -- Intermediate Technology Development Group (ITDG), Acrobat file, 284 K
http://www.itdg.org/html/technical_enquiries/docs/compost_toilets.pdf

Best of all!

"The Specialist" by Charles Sale, Putnam, ISBN 0911416005
The wonderful story of Lem Putt, country carpenter and specialist builder of privies. Lem actually existed, and Chic Sale knew him, and both lampoons him and respects him as "an artist in his way". Sale was an actor and "performed" this story hundreds of times, and by the time he wrote it (to copyright it in order to stop other actors stealing it) he had it honed to perfection. It's a rare delight. And it's more than that: Lem Putt knew his business.

"There's a lot of fine points to puttin' up a first-class privy that the average man don't think about. It's no job for an amachoor, take you my word on it. There's a whole lot more to it than you can see by just takin' a few squints at your nabor's." This is what a water and sanitation engineer who works in developing countries said about it: "If I could recommend one course book for all wastewater engineers this would be it." Not just wastewater engineers -- Lem Putt's fine points should be everybody's fine points. Full text online at the **Small Farms Library**.

"Now," I sez, "how do you want that door to swing? Openin' in or out?" He said he didn't know. So I sez it should open in. This is the way it works out: Place yourself in there. The door openin' in, say about forty-five degree. This gives you air and lets the sun beat in. Now, if you hear anybody comin', you can give it a quick shove with your foot and there you are. But if she swings out, where are you -- can't run the risk of havin' her open for air or sun, because if anyone comes, you can't get up off that seat, reach way around and grab'er without gettin' caught, now can you. He could see I was right. So I built his door like all my doors, swingin' in, and, of course, facin' east to get the full benefit of th' sun. And I tell you gentlemen, there ain't nothin' more restful than to get out there in the mornin', comfortable seated, with th' door about three-fourths open. The old sun beatin' in of you, sort of relaxes a body -- makes you feel m-i-g-h-t-y, m-i-g-h-t-y r-e-s-t-f-u-l.
-- Lem Putt, Specialist

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Vermicomposting

Composting for small farms

Whether it's in your apartment, a kitchen garden, a vegetable plot or a farm, compost is compost and making it always follows the same principles -- and gives the same benefits.

From the "On-Farm Composting Handbook" (NRAES)

Farms produce a greater bulk of organic matter, which makes it easier -- the more bulk the more forgiving the process -- and makes it harder too: how do you shift all that stuff? And how do you use it once it's made?

First, read the **Composting** section in our Organic gardening pages. Read the **Organic gardening** pages too for an introduction to organics: again, the same principles apply to farms.

The basic and best How-to's and Why-to's are still the foundation texts written by the founders of the organics movement, below.

Foundation

"The Waste Products of Agriculture -- Their Utilization as Humus" by Sir Albert Howard and Yeshwant D. Wad, Oxford University Press, London, 1931
Where Howard's famous Agricultural Testament charts a new path for sustainable agriculture, founding the organic movement at one stroke, this first book is more a practical guide to making compost: how the Indore composting system which was at the foundation of the new movement was developed, and why.
Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

"An Agricultural Testament" by Sir Albert Howard, Oxford University Press, 1940.
This is the book that started the organic farming and gardening revolution, the result of Howard's 25 years of research at Indore in India. The essence of organics is brilliantly encapsulated in the Introduction, which begins: "The maintenance of the fertility

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The way forward

of the soil is the first condition of any permanent system of agriculture." Read on! Full explanation of the Indore composting process and its application. Excellent on the relationship between soil, food and health. Full text online at the Journey to Forever **Small Farms Library**.

"Farming and Gardening for Health or Disease (The Soil and Health)" by Sir Albert Howard, Faber & Faber, London, 1945, Devin-Adair 1947, Schocken 1972
This is Howard's follow-up to An Agricultural Testament, extending its themes and serving as a guide to the new organic farming movement as it unfolded -- and encountered opposition from the chemical farming lobby and the type of agricultural scientists Howard referred to as "laboratory hermits". Lots more information about composting techniques and applications. Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

See a **review** of Albert Howard's work, plus a short bibliography and links to his major works and some of his published papers, at the Journey to Forever **Small Farms Library**.

"Pay Dirt -- Farming & Gardening with Composts" by J.I. Rodale, with an introduction by Sir Albert Howard, Devin-Adair, 1946
Inspired by the work of Albert Howard, J.I. Rodale bought a farm, founded Organic Gardening Magazine, as well as Rodale Publishing, worked tirelessly to introduce organic farming to the US, and wrote this book. A good wrap-up of the subject. Full text online in the Journey to Forever **Small Farms Library**.

"Organic Gardener's Composting" by Steve Solomon, 1993, Van Patten, Oregon
Aimed at gardeners, but relevant to all composters -- Solomon summarizes the work of the great compost developers like Howard and Rodale, along with the revolutionary wholistic health concepts of Weston A. Price and Sir Robert McCarrison. How to do it right and why it's worth it -- a good guide, simple and clear treatment. Two subjects in one book: a basic, how-to-make-compost book in Part One; and how to make really good compost in Part Two, along with an analysis of the nutritional consequences of soil fertility management choices. Focuses on thermophilic (hot) composting and vermicomposting (worms). Full text online:
http://www.soilandhealth.org/

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The **Medical Testament** published by the 31 doctors of the Cheshire Panel Committee in England on March 22 1939 was a milestone in the development of the infant organic farming movement. It acknowledged great advances in the realm of cures, but rather the opposite when it came to prevention. It also explained why this was so, and offered the remedy, plus the proof of it: "A fertile soil means healthy crops, healthy animals and healthy human beings." This is a classic document, now long out of print -- a lost classic. We tracked down a copy of the original pamphlet, plus some of the associated documents and publications -- 15 papers in all, virtually a book, all available in full-text online at the Journey to Forever **Small Farms Library**. This is what organics is all about.

Farm composting resources

"Farm-Scale Composting Resource List", Agronomy Resource List from the Appropriate Technology Transfer for Rural Areas (ATTRA) -- companion to ATTRA's "Sustainable Soil Management" Soil System Guide (same site). Reading List, References, Associations, Web Resources, Software, Magazines, Newsletters & Journals, E-mail Discussion Lists & Web Forums, Bibliographies, Current Research.
http://www.attra.org/attra-pub/farmcompost.html

"On-Farm Composting Handbook", Northeast Regional Agricultural Engineering Service, Waste Management Publications: NRAES-54, 1992, ISBN 0-935817-19-0, 186 pages, $20.00
The first recommendation on ATTRA's Farm-Scale Composting Resource List. This prize-winning handbook gives a thorough overview of farm-scale composting and explains how to produce, use, and market compost. Benefits and drawbacks, the process, raw materials, methods, operations, management, site and environmental considerations, using compost, marketing, economics, and other options for waste management, with figures, tables, calculations, references (over 160 publications), and glossary.
http://www.nraes.org/publications/nraes54.html

"Field Guide to On-Farm Composting", Northeast Regional Agricultural Engineering Service, Waste Management Publications: NRAES-114, 1999, ISBN 0-935817-39-5, 128 pages, $14.00

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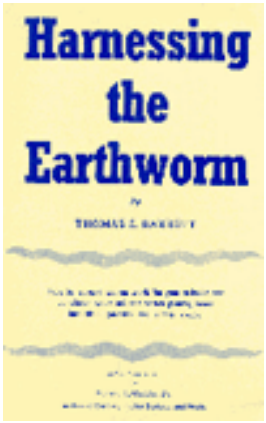
Day-to-day compost system management, for on-site use: spiral bound, printed on heavy paper with a laminated cover and chapter tabs for quick reference. It answers common questions such as optimum moisture content and bulk density, Why does my compost smell and how can I control it? How long does it take to compost dead poultry? How much compost should I apply? With a troubleshooting guide. Companion book to the "On-Farm Composting Handbook".
http://www.nraes.org/publications/nraes114.html

"Preparation and Use of Compost", Agrodok No. 8, Agrodok Publications, Agromisa Foundation, 1994, ISBN 90-72746-52-X
The Agrodok booklets are useful and practical how-to guides. Covers composting methods, composting process, organic material types, organic fertilizer, compost as fish food, practical requirements for making a good compost heap, three composting methods: Indore, Bangalore and heating-process method, all applicable worldwide. Practical use of compost in small-scale farming. Order form online:
http://www.antenna.nl/~agromisa/agrodok/ad08.html



"Harnessing the Earthworm" by Dr. Thomas J. Barrett, Humphries, 1947, with an Introduction by Eve Balfour, Wedgewood Press, 1959, Bookworm, ISBN 0916302091
"A practical inquiry into soil building, soil conditions, and plant nutrition through the action of earthworms, with instruction for the intensive propagation and use of domesticated earthworms in biological soil building." Well-researched, well-written, pioneering book on vermicomposting, very positive outlook, a refreshing read. Includes Dr George Sheffield Oliver's famous story "My Grandfather's Earthworm Farm" -- inspiring! Facts, figures and illustrations, details of Barrett's Earthmaster Culture Bed. From Vermico:
http://www.vermico.com/books.html
From City Knowledge.com:
http://www.cityknowledge.com/earthworms/order_form.html

"The Compost Connection" on-line newsletter from the Washington State University's Center for Sustaining Agriculture and Natural Resources (CSANR). On-line issues date from June 1996 to August 2000, when publication ended. Covers farm-scale compost production, compost analysis, using

compost, compost resources.
http://csanr.wsu.edu/programs/compost/compostnewsletter.htm

"Worm Digest" quarterly newsletter on using worms for composting (vermicomposting), small- to large-scale production, world-wide coverage. Networks people, information and resources. Published by the non-profit Edible City Resource Center, dedicated to the promotion of sustainable organic agriculture in urban and rural areas. Online articles, vermicomposting forum, back issues, library, large selection of books, site search, bins, harvesting, suppliers, product reviews, everything about worms and vermicomposting here.
http://www.wormdigest.org/

Large-Scale Composting Forum at OldGrowth Compost Resource Page:
http://www.oldgrowth.org/compost/forum_large/index.html
OldGrowth Compost Resource Vermicompost Forum:
http://www.oldgrowth.org/compost/forum_vermi1/

COMPOST email mailing list: for home composting but covers all types of composting, including large-scale. To subscribe, send email to:
listproc@listproc.wsu.edu
Type:
SUBSCRIBE COMPOST <YOUR NAME>
in the body of the message. Post articles to:
compost@listproc.wsu.edu

WASTENOT email mailing list for composting professionals. To subscribe, send email to:
listserv@maelstrom.stjohns.edu
type:
SUBSCRIBE WASTENOT <YOUR NAME>
in the body of the message. Post articles to:
wastenot@maelstrom.stjohns.edu

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School composting

Gardening and composting go hand-in-hand, especially in school garden projects: gardening without composting only teaches half the lesson.

Composting concerns the invisible half of the Wheel of Life, Nature's cycle of growth and decay. This is the vital part that happens underground, where wastes decay to give rise to new life. Composting helps to bring the regenerative capabilities of the soil to a high peak of natural efficiency, ensuring a bountiful, beautiful and healthy garden.

Learning about soil

Soil is made of air, water, minerals, and organic matter. The mineral portion is usually about half the total volume, water and air up to a quarter each, and organic matter about 5% or more. The mineral particles come in three sizes: biggest is sand, then silt, and clay is the smallest.

Sand is mostly quartz. Sandy soil drains well and doesn't get so muddy or sticky when it's wet, but it usually isn't very fertile because sand contains no plant nutrients. Silt is also quartz, but the particles are much smaller than sand.

Clay particles are tiny, and much more complex than sand or silt. Clay particles are tiny lattices made up of plates and can hold large amounts of plant nutrients. Clay soil can be heavy and sticky, with bad drainage, but it depends on the overall soil condition: well-maintained and composted clay soil is very fertile and not difficult to work.

Most soils are "loams", a mixture of sand, silt and clay. Soil textures range from: sand, loamy sand, sandy loam, fine sandy loam, loam, silty loam, silt, silty clay loam, clay loam, clay.

More important is the organic matter content of the soil, composed of decaying and decayed plant matter (humus) and living creatures. This is where the billions of soil microorganisms live and do their work, and if they're happy, it's a good soil, regardless of how much clay or sand it has.

An acre of good, living soil can contain 900 pounds of earthworms, 2,400 pounds of fungi, 1,500 pounds of bacteria, 133

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pounds of protozoa, 890 pounds of arthropods and algae. They're sometimes called the "micro-herd" -- the most important livestock on the farm.

It's the organic soil component that determines the soil's crumb structure and the pore space that together govern air and water circulation. You can't change the soil's texture, whether it's sandy or clay, but you can improve the structure and the soil's fertility, especially by composting.

Compost improves the soil structure ("Soil and compost" by Toshihide Matsuzaki)

To check soil composition:

1. Take a clean, clear-glass jam jar with a tight-fitting lid.
2. Spoon some soil into it -- about one-third full.
3. Add clean water up to three-quarters full.
4. Screw on the lid and shake the jar vigorously, thoroughly mixing soil and water.
5. Let it stand for a day or so.

The largest mineral particles -- sand -- sink to the bottom first, forming a distinct layer, followed by the silt, and finally the clay, giving a clear picture of the soil type. Most of the organic matter floats to the surface.

See **"Sustainable Soil Management - Soil System Guide"**, Appropriate Technology Transfer for Rural Areas (ATTRA):
http://www.attra.org/attra-pub/soilmgt.html

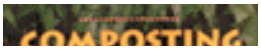
See **Composting** pages for more detail and more resources.

Composting resources for schools

These resources cover both composting and vermicomposting (composting with red worms) -- kids love worms! There are resources for both indoors and outside.

For vermicomposting, schools that do not operate year-round will need to arrange to feed the worms during the holidays. Apply a layer of compost or well-rotted horse manure every two weeks. Check the moisture level.

"Composting in the Classroom:



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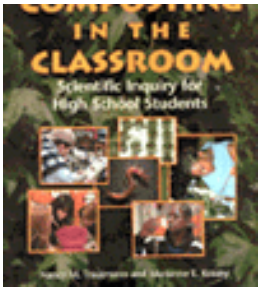
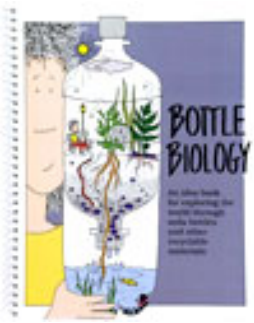


Scientific Inquiry for High School Students" by Nancy Trautmann and Marianne Krasny, Kendall/Hunt, 1997, ISBN 0-7872-4433-3
A comprehensive guide for teachers on composting research projects for high school students. Biology, chemistry, and physics of composting, instructions for building indoor and outdoor compost bins, both worm composting and thermophilic or "hot" composting, guidelines for studying the effects of compost on plant growth, and more. More details from: http://www.cfe.cornell.edu/compost/CIC.html

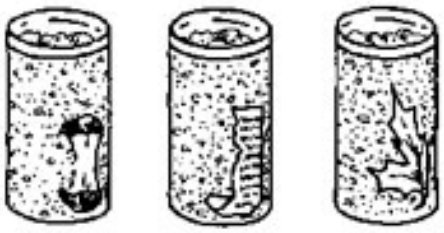
The **Composting in Schools** section at Cornell University's Center for the Environment has useful outlines for schools composting projects online (adapted from the book "Composting in the Classroom"), including lesson plans, integration with other subjects. "Why composting?" outlines some very good reasons for composting in general and for composting in the classroom in particular. Teacher's page, ideas for student research projects, compost quiz, science and engineering, composting indoors, composting outdoors, weird and unusual composting, frequently asked questions, glossary, feedback.
http://www.cfe.cornell.edu/compost/schools.html

Worm Bins -- Good overview, simple and clear guidelines and instructions from Jen Fong and Paula Hewitt at the Composting in Schools section of Cornell University's Center for the Environment. "Setting up a worm bin is easy. All you need is a box, moist newspaper strips, and worms." Covers the basics, vermicomposting in Six Easy Steps, Related Classroom Activities, Curriculum Ideas, Troubleshooting and a useful FAQ.
http://www.cfe.cornell.edu/compost/worms/wormhome.html

Building a Soda Bottle Bioreactor -- Composting in Schools, Cornell University's Center for the Environment: "Soda bottle bioreactors are designed to be used as tools for composting research. They are small and inexpensive enough to enable students to design and carry out individualized research projects, comparing variables such as reactor design, moisture content, and nutrient ratios of mixtures to be composted." Details online: http://www.cfe.cornell.edu/compost/soda.html



"Bottle Biology" -- A classroom idea book for exploring the world through soda bottles and other recyclable materials. Build a compost column, create a spider habitat, observe the life cycle of a slime mould. Filled with innovative ideas for learning about science and the environment. From the National Gardening Association's online bookstore: http://store.yahoo.com/nationalgardening/-011.html



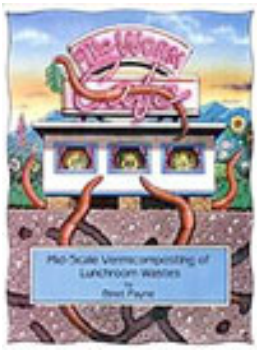
Explorations in Composting -- Simple classroom experiments using jars to help kids understand how composting helps the earth and plants, from the Communications and Environmental Education of the New Brunswick Department of the Environment. Classroom projects, how-to's, with diagrams and illustrations. How does compost help growing plants? How does compost help soil structure? Can everything be turned into compost? The Garbageless Lunch. http://www.gnb.ca/elg-egl/0372/0003/0013-e.html

Worm Bin Project -- Michigan State University College of Education and Ameritech, Middle Elementary grade. Students learn about decomposition and the life cycle via small wooden worm bins, only 5 inches square. Collect and share scientific data with students in another school via email, with directed Internet and library searches. Lesson plans online, five lessons over two months: Introduction to Worm Bin Project, Collaboration Online, Growing Plants with Worm Castings, Decomposition, Soil, and Life Cycle Research, and Presentation of Findings. http://commtechlab.msu.edu/sites/letsnet/

noframes/subjects/science/b2u1.html

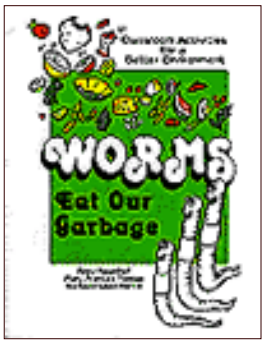
The **Adventures of Squirmin' Herman the Worm** -- On-line interactive plant science curriculum for grades 4 and 5, from Chicago Urban Gardening, University of Illinois. Teaches students the basic vocabulary of biology: biological composition, digestion and reproduction told through a guided study of the worm; principles of basic scientific research and application through the creation, observation and maintenance of a worm bin -- biological and physical sciences, fine arts, language arts, math, social sciences. My History, My Family Tree, My Anatomy, Come Live With Me, Worm Deli, Can't Live Without Me, Worm Facts, My Fun Place, Worm Links. And a Certified Wormologist certificate. Like its sister site at the Great Plant Escape, a clever, well-implemented learning site.
http://www.urbanext.uiuc.edu/worms/

Composting Resources for Teachers at Rot Web -- A great collection of resources and a compendium of different schools composting and worm composting projects at School Project Listings. Learn from schools' composting successes!
http://www.a-horizon.com/compost/teacher_resources.html



"The Worm Cafe -- Mid-Scale Vermicomposting of Lunchroom Waste" by Binet Payne, 1999, Flower Press, ISBN 0-942256-11-5
Describes how an enthusiastic teacher and her students developed a system to compost lunchroom waste with red worms, saving their school US$6,000 a year in reduced waste disposal fees. A detailed manual written for teachers, decision-makers, and activists in schools, small businesses, and community groups. Well illustrated with a wealth of useful information, useful guide for teachers interested in starting a classroom or school-wide vermicomposting program. Work sheets, a letter to parents, posters, quizzes, and a 30-page annotated guide to useful curricular materials on animals, plants, nature, and values divided into sections for children and for adults. Binet Payne based her system on "Worm Woman" Mary Appelhof's popular how-to book, Worms Eat My Garbage. Book review online:
http://www.vermico.com/bookreview.html
Order online from Mary Appelhof:
http://www.wormwoman.com/acatalog/Wormwoman_catalog_The_Worm_Cafe_4.html

"Worms Eat My Garbage" by Mary Appelhof, Flower Press, Kalamazoo, Michigan, 1982
A quick, easy read, simple and positive guide to vermicomposting by biologist Mary Appelhof, aka "Worm Woman", who's been feeding her garbage to worms for more than 20 years.
http://www.wormwoman.com/



"Worms Eat Our Garbage" by Mary Applehof, Mary Frances Fenton & Barbara Loss Harris
Worm expert Mary Appelhof's book for schools. Full curriculum for home, school and outdoor centres deals with the subject of earthworms in an interesting and informative way. Integrates science, maths, language arts, biology, solid waste issues, ecology and the environment. More than 150 worm-related activities (one per page) to develop problem-solving and critical-thinking skills. For grades 4-8. Non-copyright -- pages can be copied and used in class.
http://www.wormwoman.com/
Reviewed in Worm Digest, online:
http://www.wormdigest.org/articles/index.cgi?read=2

Vermicomposting FORUM at the Compost Resource Page -- the Education Forum is one of several forums, including Beginners Only, General Info, Bin Designs, and Archives with more than 3,000 messages from past forums, search for keywords/topics or browse a chronological section at a time. The Education Forum is for discussion of educational resources, vermicomposting in the classroom, workshops, and other discussions geared toward the instruction of vermicomposting or related topics.
http://www.oldgrowth.org/compost/forum_vermi/index.html

Classroom Projects from Vermitechnology Unlimited -- useful information on this commercial site: worm profiles, pure worm castings, cupped bait, worm bins, classroom projects. Good instructions for worm bins for schools.
http://www.vermitechnology.com/schoolprojects.htm

"Squirmy Wormy Composters" by Bobbie Kalman & Janine Schaub
Vermicomposting for children. Good color illustrations teach all about worms. How to welcome worms (with the right bin), menus for feeding them, holding and observing them, anatomy, castings value, harvesting the vermicompost, baby worms, more. From

Worm Digest:
http://www.wormdigest.org/corner-market/shop.cgi/SID=3679869/page=squirmy.html

Composting Education Resources for Teachers and Students from The Master Composter site -- links to composting curriculums, graphics, and resources all over the Internet. Online Composting Curriculums and Project Ideas, Online Recycling Curriculums and Project Ideas, more.
http://www.mastercomposter.com/educate/teachers.html

Full Educational Unit at the Reln Teachers Page for use by schools, or by parents at home, to educate children on composting and the benefits of minimizing waste, while integrating the various activities into many different classroom subjects. Lesson ideas and suggestions for primary school children. Reln makes the Can-O-Worms and Worm Factory vermicomposting bins, very useful but not essential for using these online resources.
http://www.reln.com.au/html/body_teacherspage.html

3R's -- Reduce, Reuse, Recycle: useful factsheets for Teachers and Students from the Recycling Council of Ontario. Mainly for Ontario users but can easily be adapted to other areas. Waste Audits for Schools, Recycling Activities for Children, HomeMade Paper Recipe, Waste Reduction.
http://www.rco.on.ca/factsheet/teach.html

Equipment for composting and vermicomposting projects for schools from Let's Get Growing: books, compost units, worm bins, worms, sieves, soil test kits, teacher's guides, videos and more.
http://www.letsgetgrowing.com/worms.html

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Peat moss

In Britain and parts of Europe, overuse of peat moss by gardeners and others has led to environmental concerns as bogs are depleted, and gardeners are now encouraged not to use peat moss.

Sphagnum peat moss is an alternative. Gardeners say American sphagnum moss is too tough and stringy. Use sphagnum peat moss from Canada. Don't use sphagnum moss, which is the fresh plant: sphagnum peat moss is partly decomposed and is the correct product for gardening and potting soils.

Restored Canadian bog harvested until 1968

Canadian sphagnum peat moss is not a threatened resource. See these two FAQs for more information:

Canadian Sphagnum Peat Moss and the Environment
http://www.peatmoss.com/concern.html

Peat Moss and the Environment -- **FAQ**
http://www.peatmoss.com/pm-efaq.html

Check with local environmental organizations or gardening associations whether using locally available peat moss or alternatives causes environmental damage or not.

Coco peat moss

An alternative is **coconut coir**, the waste-product from coconut shells. It is widely available, usually in the form of bricks or bales, and it works well -- use it like peat moss. Coir mostly comes from Sri Lanka, India or the Philippines. Sri Lanka produces about a million cubic metres of coir a year and has a large surplus.

Coir bricks

"Coconut Husk Fiber is an excellent potting medium. This great replacement for peat moss does not shed water like peat moss, and holds up to ten times its weight in water. After soaking in water for 10-20 minutes, you will have 1/3-1/2 cubic foot of weed- and disease-free material. The pH of this potting medium is between 5.2-6.8." From the **Territorial Seed**

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Company:
http://www.territorial-seed.com/testcat/hardgoods/planting/ZPT697.html

"One small brick makes approximately 4 quarts of fluffy, wonderful smelling soil amendment" -- From **Golden Harvest Organics**:
http://www.ghorganics.com/Cocopeat.html

Jayampathi Lanka Exports (Pvt) Ltd. of Sri Lanka makes and exports **Fibrosoil Coco Peat** products -- Briquettes, Coco Peat Discs, Coco Peat Grow Bags and bagged or baled Coco Peat. E-Mail:
jayampathi@lanka.ccom.lk
http://www.jayampathi.com/
Also in Australia:
http://www.cocopeat.com.au

Coconut Coir -- Wrapped Bricks, Blocks, Bales and Coir Grow Poles from **Caribbean Gardening**: 8x4x2" Brick of Coconut Coir compressed 8 to 1 -- add one gallon of hot water and it expands to 1/3 cubic foot or 9 quarts. Blocks are compressed 5 to 1 and expand to 2.5 cubic feet (75 quarts). Bales are compressed 2 to 1 and expand to 8 cubic feet (240 quarts)
http://www.coconutstuff.com/products.htm

Coir Fibre Brick -- The Organic Gardening Catalogue, **Chase Organics-HDRA**: Compressed coir fibre which expands to make a compost base when soaked in water. One brick makes 8 lt of coir which is enough for 2 seed trays. Use neat for sowing. Mix with perlite for cuttings. Add nutrients for raising transplants. One-, 2-, or 8-brick packs. See "Growing Media" in online catalogue -- Catalogue Ref: PFBR. Delivery in the UK only.
http://www.organiccatalog.com

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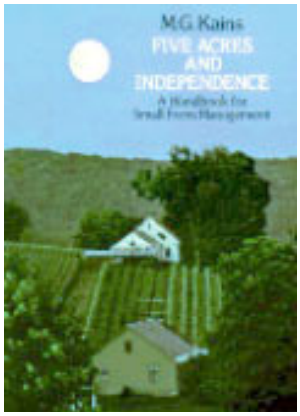
Farming with animals

Small farm resources

Back to the land -- a 140-year trend

"Ten Acres Enough: The Small Farm Dream is Possible" by Lynn R Miller, Ralph C Miller, Edmund Morris, 1864, 2nd Edition 1996, Small Farmers Journal, ISBN 1885210035
First published in 1864, this is the journal of a man who moved from the city to the country a hundred years before it became the fashion. It's the story of his experiences building a small farm and living the simple life, with his advice on a range of topics such as buying land, planting peaches and berries, livestock, weeds, liquid manure, and hard financial realities. It was possible then, and it's possible now. Read it online at the Making of America (MOA) digital library:
http://moa.umdl.umich.edu/cgi/sgml/moa-idx?notisid=AJR0739

"Three Acres And Liberty" by Bolton Hall, 1907, Macmillan
This original back-to-the-land book is much more than a how-to, also a why-to, and Hall's reasons are as clearcut today as they were 93 years ago. From the Foreword: "We are not tied to a desk or to a bench; we stay there only because we think we are tied. In Montana I had a horse, which was hobbled every night to keep him from wandering; that is, straps joined by a short chain were put around his forefeet, so that he could only hop. The hobbles were taken off in the morning, but he would still hop until he saw his mate trotting off. This book is intended to show how any one can trot off if he will." Soil and Health Library keeper Steve Solomon writes: "With a broad sense of history that would do justice to someone of our own era, Hall observes the social forces propelling people into city poverty when they could live with simple liberty and plenty in the country." Out of print, full text online at the Soil and Health Library:
http://www.soilandhealth.org/



"Five acres and independence: a practical guide to the selection and management of the small farm" by Maurice Grenville Kains, 1935, 1973, Dover Publications, ISBN 0486209741
Another great back-to-the-land classic on the basics of self-sufficient farming, covers all aspects of making a small acreage profitable and livable. First published in 1935, still in demand and still in print. Costing information and some other details

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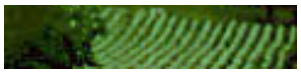
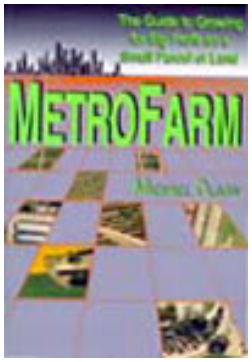


are out of date now, but the principles remain intact -- eg, the chapter on "Tried and True Ways to Fail". From Powell's Books:
http://www.powells.com/biblio/46600-46800/0486209741.html
From Lehman's Non-electric Catalog:
http://www.lehmans.com/cgi-bin/ncommerce3/ProductDisplay?prmenbr=12426&prrfnbr=14484&FROM_CAT_REF=12822

"The Have-More Plan: A Little Land -- A Lot of Living" by Ed and Carolyn Robinson, Storey Books, ISBN 0882660241
This homestead classic from the 1940s encouraged thousands to go "back to the land" to seek a better life after the Great Depression and World War II. It has been in constant demand since it was first published. A wealth of information for anyone seeking a self-reliant lifestyle. All the basic information to get started, good on property layout and building design for optimum use of space and time, useful, detailed guide. The style is dated but the message isn't!
Order online from Countryside Magazine:
http://www.countrysidemag.com/books/hmp.htm
From Storey Books:
http://www.storeybooks.com/sell_sheet_frames/garden/024-1prim.html

"How to Make $100,000 Farming 25 Acres: With Special Plans for Prospering on 10 to 200 Acres" by Booker T. Whatley, 196 pp, $23.95
Ten practical steps from a small farm authority. Year round, daily cash flow. Good detail and full of how-to drawings and practical advice.
From Powell's Books -- "Search" for "Booker T. Whatley":
http://www.powells.com/



"MetroFarm: The Guide to Growing a Big Profit on a Small Parcel of Land" by Michael Olson, 1994, ISBN 0-963787-60-8
According to a recent US Census of Agriculture, the most productive farmland in the US is in the Borough of the Bronx, the second most productive farmland is in the City of San Francisco. How to earn up to eight times the average personal income on as little as one acre of land. Written for both the experienced and the novice, both modern and traditional technologies used by space-intensive farmers from around the world. Photos, charts and illustrations. From ECHO's Global Bookstore
http://echonet.org/shopsite_sc/store/html/MetroFarm.html
From MetroFarm Online:
http://www.metrofarm.com/book.htm

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"On Good Land: The Autobiography of an Urban Farm" by Michael Ableman, 1998, Chronicle Books, ISBN 0811819213
Opens with an aerial photograph of the 12.5-acre Fairview Gardens Farm in California in 1954, part of thousands of acres of farmland, and again in 1998, surrounded by the homes and malls of a modern suburb. Ableman simply refused to let it be bulldozed -- he's in love with the place. And it's not even his: he's a tenant farmer. But it's the land itself and what it produces that matters to him. Now it's become the organically farmed Center for Urban Agriculture. Ableman's struggles and success make an inspiring story. "Michael Ableman's farm is a landmark, a source of comfort to all of us who love good farming and good food. A lot of people are grateful to him, and I am one of them." -- Wendell Berry. From Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=6-0811819213-0

Small farms

"Successful Small-Scale Farming" by Karl Schwenke, 1991, Storey Books, ISBN 0882666428
The potential and the harsh realities of living on the land. Covers organic soil management, essential machinery, market strategies, basic skills, lots of useful charts and tables. Small farms can be cleaner, smarter, and more efficient than corporate agribusiness, says Schwenke -- indeed so. Concise overview and how-to's, for one acre and up. Lehman's Non-electric Catalog:
http://www.lehmans.com/cgi-bin/ncommerce3/ProductDisplay?prmenbr=12426&prrfnbr=14485&FROM_CAT_REF=12822
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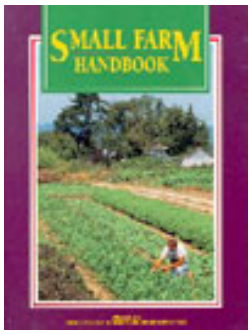
http://www.storeybooks.com/new_sell_sheets/642-8.html



"Small Farm Handbook", Small Farm Program at UC Davis. A practical, easy-reading guide for people interested in operating a successful small farm. Tips on livestock and crop production, buying property and equipment, dealing with taxes and regulations, marketing, maintaining healthy family relationships, and more. Easy-to-use worksheets to fit your farming goals. Thirty-eight authors -- researchers, farm advisors, small farm specialists, and farmers -- covering all aspects of owning and operating a small farm: Requirements for Successful Farming, The Basics, Finances, Marketing, Selling your Product, Enterprise Ideas, Growing Crops, Raising Animals, Postharvest, Alternative Agriculture, Labor Management, Keeping the

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Eco-footprint

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Children's poetry

Contact us

To Keith Addison
keith@journeytoforever.org
To Midori Hiraga
midori@journeytoforever.org
Homepage
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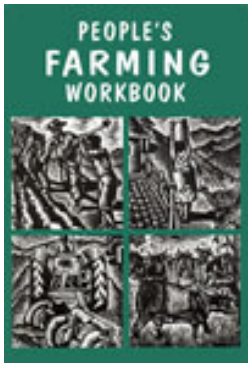
Ichijima
Japan

Family Farm Healthy, Worksheets, resources and references.
http://www.sfc.ucdavis.edu/docs/sfhandbook.html
Order online:
http://anrcatalog.ucdavis.edu/merchant.ihtml?pid=816&lastcatid=103&step=4

"Grow It! -- The Beginner's Complete In-Harmony-With-Nature Small Farm Guide -- From Vegetable and Grain Growing to Livestock Care" by Richard W. Langer and Susan McNeill (illustrator), first published in 1972, reissued 1994, Noonday, ISBN 0374523908
Practical and easy-to-use guide to small-scale organic farming, packed with good advice on "everything from building and stocking a pond to planting an orchard or making cheese". Read it or use it as a quick-reference guide. From Powell's Books (use "Search"):
http://www.powells.com/



"People's Farming Workbook" Environmental and Development Agency Trust, David Philip, Cape Town, South Africa, 1995, ISBN 0 86486 112 5
For rural and resource-poor communities, the Workbook has obviously grown from the ground up, like a good crop: written by a collective, the authors know the needs of the grass-roots people the book targets. It's easy to read and easy to use, well-illustrated and well-organized to meet the needs of everyone from small farmers to backyard gardeners with little time and few resources. Simple without being simplistic, it's a mine of sheer usefulness -- an object-lesson for some of the expensive, top-heavy programs that set out to help poor rural people. Applicable anywhere in the Third World, not just South Africa. From David Philip Publishers, Cape Town, South Africa. E-mail: dpp@iafrica.com fax: +27 21 64 3358
Order online from Stylus Publishing:
http://www.styluspub.com/books/book3041.html
From Intermediate Technology Development Group Bookshop
http://www.developmentbookshop.com/book.phtml?isbn=864861125
From Maya Books:
http://www.mayabooks.ndirect.co.uk/agriculture.htm

"Amaranth to Zai Holes: ideas for growing food under difficult conditions" by Laura S. Meitzner and Martin L. Price, 1996, ECHO (Educational Concerns for Hunger Organization). This book is an updated compilation of 15 years of ECHO's quarterly technical bulletin, ECHO Development Notes. "Amaranth is a drought-tolerant plant which provides both high-protein grain and delicious edible leaves. Zai holes use termites to

improve soil fertility and increase water filtration in farmers' fields in West Africa. These are just two of the plants and techniques people are using to produce food under difficult growing conditions in the tropics." A treasurehouse of practical information for and from the field, mainly for people working with small farmers or urban gardeners in Third world settings -- new ideas, techniques, underutilized tropical plants, and offers of trial packets of seed to evaluate them. Online version: http://www.echonet.org/tropicalag/aztext/index.htm
Order the book online:
http://echonet.org/shopsite_sc/store/html/AmaranthToZaiHoles.html

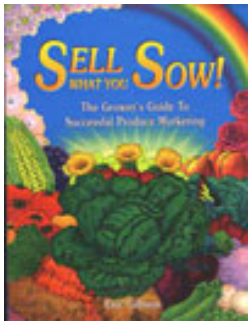
"Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture" by Robert McC. Netting, 1993, Stanford University Press, ISBN 0804721025
A detailed analysis of the livelihoods of farmers practising intensive, diversified and sustainable agriculture. Focuses on small farms in areas of dense population around the world. Well-researched ethnographic review of agricultural practices and their social and economic aspects, many examples showing how intensive, diversified farming systems are often efficient and sustainable alternatives to modern chemical and fossil-fuel dependent agriculture. From Fertile Ground Books:
http://www.agaccess.com/cgi-bin/webc.cgi/~fg/st_prod.html?p_prodid=STA013&sid=22zsARv
From Cambridge University Press (UK):
http://uk.cambridge.org/anthropology/catalogue/0804721025/default.htm

"Making Your Small Farm Profitable" by Ron Macher, 1999, Storey Books, ISBN 1580171613
Ron Macher is the editor of Small Farm Today magazine ("Our readers make money!"), the original how-to magazine for small farmers, established in 1984. This is a good overview for anyone wanting to start a small, sustainable farm and make a profit.
Order from Small Farm Today:
http://www.smallfarmtoday.com/BackIssues.shtml
From Storey Books:
http://www.storeybooks.com/new_sell_sheets/161-3.html

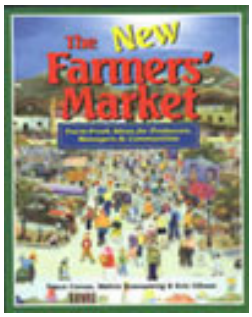
"Small Farm Today" bi-monthly magazine for small-acreage landowners and small farmers: "Make a profit on your farm!" The original how-to magazine of alternative and traditional crops, livestock, and direct marketing, established in 1984. How-to articles on profitable livestock, wool and fibre, poultry, draft animals, vegetable and small fruit crops, aquaculture, marketing, gardening, farm equipment, rural/home-based businesses. "Small farms (178 acres or less, grossing

$40,000 a year or less) are 80% of the farms in the US, and small farm numbers are expected to increase 17.4% over the next 10 years; 47% of our readers have been farming less than five years, and 76% farm 100 acres or less." Each issue has a theme.
http://www.smallfarmtoday.com/

Growers' Connection: Books & online resources for small farm marketing and farmers' markets, with links to a wide variety of small farm and sustainable agriculture topics.
http://www.nwpub.net/



"Sell What You Sow! The Grower's Guide To Successful Produce Marketing", by Eric Gibson, 1993, New World Publishing, ISBN 0963281402
This how-to book that reveals the tricks of the trade from master marketers around the US. High-value produce marketing for farmers and market gardeners, hands-on information, practical, how-to guidance on selling what you grow and making profits from produce. "Far-and-away the outstanding farm produce marketing text. If you're trying to sell what you grow, this book will quickly pay for itself" -- Small Farmer's Journal.
http://www.nwpub.net/swys.html



"The New Farmers' Market" by Vance Corum, Marcie Rosenzweig & Eric Gibson, 2001, New World Publishing; ISBN: 0963281429
If you want to succeed at farmers' markets in the US, this is the book for you. A "must have" for farmers' market sellers, managers, market planners, and farmers' market community. "Finally, a really good book on farmers' markets!" -- Growing For Market newsletter.
http://www.nwpub.net/tnfm.html

"Countryside & Small Stock Journal -- The Magazine of Modern Homesteading" -- promoting self-reliance and simple life style through home food production, gardening, cooking, food preservation and other homesteading techniques. "83 years old, and a new wrinkle with every issue!" Gardening, small-scale livestock, cooking, food preservation, resource conservation, recycling, frugality, money management, alternative energy, old-time skills, home business, and more. Useful how-to's and practical information, detailed and well-written -- stuff you need to know. Features from back issues online, back issues available (unless sold out), contents listed. Good bookstore, lots of useful guides and resources for the homesteader.
http://www.countrysidemag.com/

"Tools for Agriculture: A guide to appropriate equipment for

smallholder farmers" by Ian Carruthers and Marc Rodriguez, 4th edition 1992, Intermediate Technology, ISBN 185339100X
Unique guide to small-scale farming equipment. Each subject is introduced by an expert who sets the available tools against the background of good farming practise. Helps you evaluate what's most suitable for your situation. Analyses why some projects are successful and suggests ways to improve them. Land preparation, sowing and fertilizing, pest control, harvesting, water lifting, livestock care, and beekeeping. With lists of manufacturers (mostly in the Third World). From IT Publishing:
http://www.developmentbookshop.com/book.phtml?isbn=185339100X

"The Scythe Book" by David Tresemer, 1981, Reprint 1996, Alan C. Hood, ISBN 0-911469-14-1
"In this age when most wonder how you can accomplish anything without the aid of electricity or gasoline, we must reassert that a hand tool finely made has greater versatility, has comparable efficiency even in large areas, and even makes for good exercise because the tool fits the dynamics of the body. Most importantly, a finely made tool does not interfere with personal communion with the ever-amazing natural world." A well-researched manual on the (almost) lost art of using a scythe: how to use a scythe with little effort. Tresemer delves into subjects such as the Alexander Technique, relaxation and mind-body techniques to explain the relaxed, natural swing that cuts the best -- Zen and the art of the scythe (though he doesn't say so). Interesting recounting of the history of the scythe (it took about 2,000 years to develop it). Includes sections on scythe maintenance and harvesting and processing small grains. A real pleasure to read. From Lehman's Non-electric:
http://www.lehmans.com/cgi-bin/ncommerce3/ProductDisplay?prmenbr=12426&prrfnbr=14487&FROM_CAT_REF=12822

Scythe Supply offers high-quality European-style scythes, scythe blades, snaths, whetstones, hammers, anvils and equipment. "We are scythe enthusiasts and want others to discover this wonderful tool." Lots of content and a workshop section with how-to explanations and photos.
http://www.scythesupply.com/

"The Smallfarming Revolution -- New beginnings in rural New Zealand" by Ian and Dianne Grant, 1998, Penguin. Part 1 -- The smallfarming way of life; 25 Secrets of Successful Smallfarmers; Promising Smallfarming Ventures. Part 2 -- 21 case studies of different types of small

farms and small farm enterprises throughout New Zealand. For new and budding small farmers and existing farmers looking for new ideas. From Smallfarmers Association of New Zealand:
http://www.smallfarmer.org.nz/trading.htm

The **Small Farm Resource** -- "created to help disseminate information of use to people with small farms or rural property. This is a cooperative effort. Some of our information comes from people like you." Emphasis is on practical information you can use. Covers Aquaculture, Bees and Beekeeping, Forage Crops, Orchard/Fruit, Other Crops, Equipment, Extension, Gardens, Livestock, Pests, Property Management, Wildlife. Crops--Forage, for instance, takes you to an index of 18 forage crops, each with a useful FAQ, followed by Related web pages, Commercial suppliers, Electronic mailing lists, Suggested references, Periodicals. Very useful. Prefers safety, but not a strictly "chemical-free" site -- use your discretion.
http://www.farminfo.org/index.html

Country Smallholding -- Britain's Smallholding Site. "Country Smallholding" magazine was started as a bi-monthly in 1975 by David and Katie Thear at a time when there was no publication available for smallholders and the whole climate was one of intensive, chemical farming. They learnt to cultivate the soil organically and to raise animals and poultry humanely -- efforts supported by John Seymour, the self-sufficiency author, Lawrence D. Hills, founder of the Henry Doubleday Association, Britain's main organic society, and Dr Fritz Schumacher, author of "Small is Beautiful: A Study of Economics as if People Mattered". Initially called Practical Self Sufficiency, then Home Farm, now Country Smallholding. Subscribe online, site has good resources for smallholders: wide selection of books on smallholding subjects, extensive set of British links.
http://www3.mistral.co.uk/cgs/

The **Smallholding Plan** from Britain's Country Smallholding magazine provides a blueprint for anyone about to buy a smallholding or who wishes to make productive use of a little land -- anything from a large garden and small orchard to several acres. Sage advice here -- David and Katie Thear are veterans at the smallholding game. Subjects covered: buying a country property, the kitchen garden, chickens, ducks, geese, turkeys, quail, rabbits, sheep, goats, house cow, pigs, bees. Each with Key factors, Space, Time, Energy and Money, and Further information. Useful.
http://www3.mistral.co.uk/cgs/smallhol.htm

Backwoods Home Magazine sets out to help you achieve a more

self-sufficient lifestyle for yourself and your family. Solid, practical, hands-on information on a wide range of self-reliance topics, written by people who are out there doing it. Country living, building a homestead, tools, gardening, livestock, alternative energy, making a living, self-sufficiency, preparedness, homeschooling, crafts, nature, how-to's, achieving independence, and more. This magazine is a great resource. Six anthologies available (special offers), back issues, selected articles online, and a good bookstore.
http://www.backwoodshome.com/

Homestead.org Online Homesteading and Small Farming Resource -- excellent site for back-to-the-landers. What is homesteading/What is a homesteader? -- Aren't homesteaders just [survivalists/hippies/eco-nuts/etc.]? -- How does one begin homesteading? -- Where can I get more information? Right here is a good place to start. How-to's and other articles, bookstore -- old copies of Mother Earth News and more, Homesteading FAQ, large collections of resources on agriculture, animals, everything else to do with sustainable farming, and a Kids' Korner. Most resources conveniently grouped into Internet Sites, Literature, Organizations, Suppliers, Usenet Newsgroups.
http://www.homestead.org/

Homestead Links is a searchable directory of more than a thousand categorized websites of use to homesteaders. Agriculture, Education, Energy Sources, Gardening, Homesteaders Home Pages, Indoors, Library, Livestock, Outdoors and more. Online forums. Good site search, interesting selection of books in the library. Useful site -- some of the links are too mainstream-conventional for smallholders, but generally a useful resource.
http://www.segues.com/homesteadlinks/

HOMESTEAD Discussion Group -- Internet community of several hundred homesteaders.
Subscribe: email listserv@unc.edu, leave subject blank, in the body of the email, type:
subscribe Homestead
Or subscribe online:
http://help.unc.edu/?id=62#d0e86

The Homesteading Discussion Web forum -- all topics related to homesteading, including keeping farm animals, growing grains and feed, making soap, or whatever is necessary to be self-sufficient. Read messages and post replies online, archives (long), no archive search but you can search the whole site. Hosted by Country Life Online, run by Lehman's Non-electric. See "Discussions -- Choose a board":
http://www.countrylife.net/

See also Appropriate technology agriculture resources

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Farming with animals

Small farm resources

Organics

"An Agricultural Testament" by Sir Albert Howard, Oxford University Press, 1940.
This is the book that started the organic farming and gardening revolution, the result of Howard's 25 years of research at Indore in India. The essence of organics is brilliantly encapsulated in the Introduction, which begins: "The maintenance of the fertility of the soil is the first condition of any permanent system of agriculture." Read on! Full explanation of the Indore composting process and its application. Excellent on the relationship between soil, food and health. Full text online at the Journey to Forever **Small Farms Library**.

"Farming and Gardening for Health or Disease (The Soil and Health)" by Sir Albert Howard, Faber & Faber, London, 1945, Devin-Adair 1947, Schocken 1972
This is Howard's follow-up to An Agricultural Testament, extending its themes and serving as a guide to the new organic farming movement as it unfolded -- and encountered opposition from the chemical farming lobby and the type of agricultural scientists Howard referred to as "laboratory hermits". Together, the two books provide a clear understanding of what health is and how it works. Full text online at the Soil and Health Library: http://www.soilandhealth.org/

"The Waste Products of Agriculture -- Their Utilization as Humus" by Sir Albert Howard and Yeshwant D. Wad, Oxford University Press, London, 1931
Where Howard's famous Agricultural Testament charts a new path for sustainable agriculture, founding the organic movement at one stroke, this first book is more a practical guide to making compost: how the Indore composting system which was at the foundation of the new movement was developed, and why. Full text online at the Soil and Health Library: http://www.soilandhealth.org/

"Sir Albert Howard In India" by Louise E. Howard, Faber & Faber, London, 1953, Rodale 1954
Albert and Gabrielle Howard worked as fellow plant scientists and fellow Imperial Economic Botanists to the Government of India for 25 years, and this is a study of their work by Sir Albert's second wife Louise (sister of Gabrielle, who died in 1930). It's a classic study of effective Third World development work. Initially involved with improving crop varieties, the pair soon concluded it was futile to fiddle with seeds unless the work took full account of the system and circumstances as a whole. Thus developed a sustained interest in putting agricultural research into its right relation with the needs of the people, and a fundamental belief in

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peasant wisdom. Results were useful only if they could be translated into peasant practise. This led to the development of the famous Indore system of composting organic wastes: improved seeds were no use in impoverished soils. It's a great story. Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

"The Earth's Green Carpet" by Louise E. Howard, 1947, Faber & Faber, London
In this unusually clear book, Lady Howard (the wife of Sir Albert Howard, founder of the organic movement), has written a "layman's introduction" which is also a work of literary distinction. Her subject is nothing less than the life cycle studied as a whole, and this leads inevitably to the importance of a reformed agriculture for the health of the community. She saw the need for a popular introduction to her husband's revolutionary ideas and principles, and her book draws a vivid picture of what lies behind the appearance of the Earth's green carpet. "Nature is not concerned to give us simple lessons," Lady Howard says -- and yet she transmits them here with admirable simplicity and clarity, a delight to read. Truly a classic. Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

See a **review** of Albert Howard's work, plus a short bibliography and links to his major works and some of his published papers, at the Journey to Forever **Small Farms Library**.

"Towards a Sustainable Agriculture -- The Living Soil", by Lady Eve Balfour. This classic text on the organic movement is an address given by the late Lady Eve Balfour, author of the organics classic "The Living Soil and the Haughley Experiment", to an IFOAM (International Federation of Organic Agriculture Movements) conference in Switzerland in 1977. Full text online at the Journey to Forever **Small Farms Library**.

Eve Balfour at Haughley (The Soil Association)

"The Living Soil and the Haughley Experiment" by Lady Eve B. Balfour, Faber & Faber, London, 1943
Eve Balfour was a key figure in the forming of the organic gardening and farming movement, and one of the founders of Britain's Soil Association. She divided her estate at Haughley into two sections, one organic, and the other run "conventionally", with chemical fertilizers. This book records the results, and her insights. "The health of soil, plant, animal and man is one and indivisible," she said. She practised what she preached, and reaped the benefits -- Lady Eve died in her 90s, healthy and alert to the end. This is an informative, thoughtful and inspiring book any gardener will want to read. Full text online at the Soil and Health Library:

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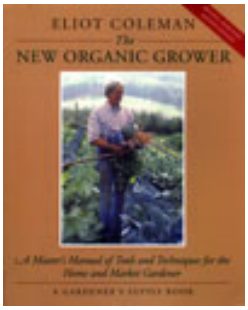
PicoTurbine
Low-tech radio
What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox

http://www.soilandhealth.org/

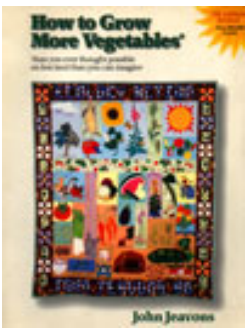
Organic grower and author Steve Solomon's online **Soil and Health Library** is a treasurehouse of classic texts that are now almost impossible to find. There are no modern replacements for these books.
http://www.soilandhealth.org/

"**Pay Dirt -- Farming & Gardening with Composts"** by J.I. Rodale, with an introduction by Sir Albert Howard, Devin-Adair, 1946
Inspired by the work of Albert Howard, J.I. Rodale bought a farm, founded Organic Gardening Magazine, as well as Rodale Publishing, worked tirelessly to introduce organic farming to the US, and wrote this book. A good wrap-up of the subject. Full text online at the Journey to Forever **Small Farms Library**.

The **Medical Testament** published by the 31 doctors of the Cheshire Panel Committee in England on March 22 1939 was a milestone in the development of the infant organic farming movement. It acknowledged great advances in the realm of cures, but rather the opposite when it came to prevention. It also explained why this was so, and offered the remedy, plus the proof of it: "A fertile soil means healthy crops, healthy animals and healthy human beings." This is a classic document, now long out of print -- a lost classic. We tracked down a copy of the original pamphlet, plus some of the associated documents and publications -- 15 papers in all, virtually a book, all available in full-text online at the Journey to Forever **Small Farms Library**. This is what organics is all about.



"The New Organic Grower -- A Master's Manual of Tools and Techniques for the Home and Market Gardener" by Eliot Coleman, Chelsea Green, Vermont, 1989, 1995, ISBN 0-939931-75-X
By a master -- "a quiet leader in the American organic movement" -- but this book is for anyone serious about the subject. Coleman is an organic farmer and gardening tools consultant, and he and his wife host the popular TV series "Gardening Naturally" on the Learning Channel. From Chelsea Green:
http://www.chelseagreen.com/Coleman/index.html



"How To Grow More Vegetables -- than you ever thought possible on less land than you can imagine" by John Jeavons, Ten Speed Press, Berkeley, California, 1974, 1995, ISBN 0-89815-767-6.
John Jeavons is director of Ecology Action, main protagonists of English master gardener Alan Chadwick's Biointensive gardening method. Now in its fifth edition. Not just vegetables, also fruits, nuts, berries and other crops -- more crops on less land using much less water, achieving high yields while building soil fertility instead of depleting it.

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midori@journeytoforever.org
Homepage
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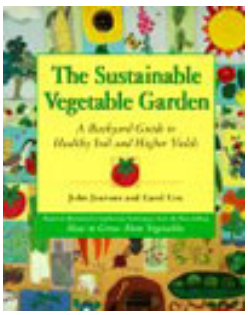
Ichijima
Japan

Ecology Action is helping to revolutionize sustainable gardening and mini-farming in 108 countries around the world. "A gardener may be able to grow his or her own 322 pounds of vegetables and soft fruits in a four-to-six month growing season on as little as 100 square feet." This is a book to use -- bet you'll get it muddy! From Ecology Action:
http://www.growbiointensive.org/biointensive/book.html
Ecology Action home page:
http://www.growbiointensive.org/



"The Sustainable Vegetable Garden: A Backyard Guide to Healthy Soil and Higher Yields" by John Jeavons, Carol Cox, 1999, Ten Speed Press, ISBN 1580080162
This introduction to biointensive gardening shows that it is not only possible but easy to grow astonishing crops of healthful organic vegetable and fruits, while conserving resources and helping the soil. More than just an abridged version of Jeavons' ""How To Grow More Vegetables -- than you ever thought possible on less land than you can imagine", it makes many of the key concepts easier to understand and put into practice. It is full of useful diagrams which will be invaluable to the novice and expert alike. You don't just read about how to 'double dig' a bed -- there are step by step images to help you see exactly how it's done. Just about everything you need to know is covered, clearly and concisely. From Ecology Action:
http://www.growbiointensive.org/biointensive/book.html

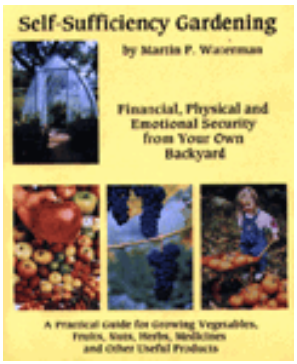
Don't Panic Eat Organic ("An organic growers' homepage! It is growing like everything else around here!") -- if it's about organics or anything related to organics you'll find it here. Very extensive. And the site's had a quarter of a million visitors.
http://www.rain.org/~sals/my.html

Biodynamic Farming and Gardening Association (BDA) Home Page -- "Based on a series of lectures given by Austrian philosopher Rudolf Steiner in 1924, Biodynamics is a method of agriculture which seeks to actively work with the health-giving forces of nature. It is the oldest non-chemical agricultural movement, predating the organic agriculture movement by some 20 years and has now spread throughout the world." Biodynamics is very impressive, in its wholism, its results, and its science.
http://www.biodynamics.com/

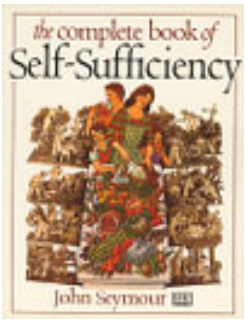
InterGarden -- a large and fine collection of resources on organics, Permaculture, sustainable agriculture, composting, renewable energy, literature, FAQs, lots of links and just about everything else you could want at Lawrence London's InterGarden site.
http://www.ibiblio.org/intergarden/

"Production Without Destruction", Natural Farming Network,

Zimbabwe. Primer on organic growing and a manual for teachers of sustainable systems, and a good handbook for beginners in tropical agriculture. Clearly-written with charts or pictures on most pages, useful textbook and reference on a wide variety of topics: Agriculture and ecological systems, Soil, Water, Plant propagation, Trees, Pests and Weeds, Managing a sustainable farm, Improved gardening practises, Dryland cropping, Integrating animals, and more. Other Natural Farming Network publications: Groundcover magazine, Natural Pest and Disease Control, Introduction to Permaculture, Amajuba Coffee, Water Harvesting Innovations. Order from the Natural Farming Network at Box CY301, Causeway, Harare, Zimbabwe. Tel 72 6538/731541, fax 723056



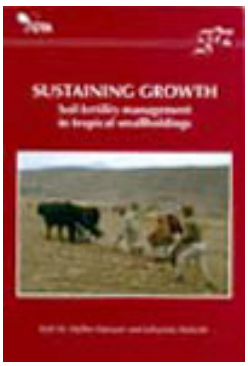
"Self-Sufficiency Gardening: Financial, Physical and Emotional Security from Your Own Backyard" by Martin P. Waterman, 1995, ISBN 1-55950-135-9
Waterman is a widely respected horticulturist and journalist. Practical guide for the novice and experienced gardeners. Covers the basics, organic growing, edible landscaping, greenhouses, preserving and storing, non-food and other valuable crops, earning income with your crops, and more. Traditional, time-honoured gardening techniques along with computer-gardening technology. Waterman writes gardening articles for Backwoods Home Magazine, among others. This is what the magazine's publisher Dave Duffy said about this book: "If you're going to read just one gardening book in the 90s, this is the book Backwoods Home Magazine will stand behind." From Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=1-1559501359-2
From Safety Central:
http://www.safetycentral.com/selgarbymarp.html



"The Complete Book of Self Sufficiency" by John Seymour, 1976, 1997, Dorling Kindersley, ISBN 0751304263
Seymour has been described as the 'guru' of self sufficiency and says it all in this book. From planning a 1 or 5 acre plot to crop rotation, from making bread to building a furnace. Essential accessory to self-sufficiency, whether you need to remove a tree stump, butcher livestock, harness a ploughhorse, plan a dairy or dress stone. Features many forgotten crafts that have been lost to convenience food and supermarkets. Comprehensive. Great drawings and all the information you need. From Amazon.co.uk:
http://www.amazon.co.uk/exec/obidos/ASIN/0751304263/qid=979231196/202-7185636-5219825

"Tools for Organic Farming -- A Manual of Appropriate Equipment and Treatments", George McRobie (editor), 1989, Intermediate Technology
Small-scale and relatively affordable equipment for organic farmers, wherever they are in the world, with the emphasis on developing countries. Warns against chemical pesticides and describes how to use natural crop protection methods. Lists suppliers and manufacturers. The sustainable production system, Crop protection, Seed. bed preparation and intercultivation, Sowing, planting, and fertilizer distribution, Harvesting and post-harvest crop processing, Appendix on Water-lifting pumps and other equipment, Manufacturers' index. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/ToolsOrganicFarming.html
From Maya Books:
http://www.mayabooks.ndirect.co.uk/agriculture.htm

Soil management



"Sustaining Growth: Soil Fertility Management in Tropical Smallholdings" by Karl M. Muller-Samann & Johannes Kotschi, 1994, GTZ
A range of practises for sustainable agriculture development of smallholdings in the tropics focusing on the maintenance of soil fertility using a minimum of external inputs. The book is a compilation of recent research results and practical experience as well as a re-examination of older knowledge that has fallen out of circulation. "Agroforestry, green manuring, the use of manure, mulch, compost, and natural symbionts -- all are ancient methods about which too little is yet known by modern science. They represent a vast untapped potential, especially for small-scale farmers with little or no access to external inputs. The first edition of this book appeared in German in 1986. It met with such a favorable response that we decided to have it translated into English. It has also been updated and extended to include recent findings in the fields of agroforestry and green manuring. Our aim is also to help widen the circle of scientists and development workers willing to actually do something to promote soil fertility instead of merely wringing their hands and beating their breasts." -- Hans Wilhelm von Haugwitz, Deputy Director Planning and Development Division, GTZ. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/SustainingGrowth.html

"Sustainable Soil Management", Soil System Guide from Appropriate Technology Transfer for Rural Areas (ATTRA): ATTRA's online guide series is excellent, and this one is no exception. Good introduction to all aspects of fertility management. "How does soil in its native condition function? How do forests and native grasslands produce

plants and animals in the complete absence of fertilizer and tillage? What are the principles by which these soils function? The answers to these questions assure that the soil will be productive and profitable now and for future generations. A good thing happens when the soil's natural productivity is managed in a sustainable way; the reliance on purchased inputs declines, while land value and income generation increase year by year. Some of the things we spend money on can be done by the natural process itself for little or nothing. It's an upward spiral of continued success."
http://www.attra.org/attra-pub/soilmgt.html

See also ATTRA's "Making the Transition to Sustainable Farming -- Fundamentals of Sustainable Agriculture" below.

Sustainable farming

ATTRA -- Appropriate Technology Transfer for Rural Areas (US) is the national sustainable farming information centre operated by the private nonprofit National Center for Appropriate Technology (NCAT). Large and well-selected set of resource links on sustainable farming, US and worldwide, from what-is to how-to. Technical assistance, publications, and resources free of charge to "appropriate users". ATTRA's on-line guides are some of the best resources available -- highly recommended. Systems Guides, Technical Notes, Resource Lists, includes Farmer Profiles: ATTRA Materials List, Fundamentals of Sustainable Agriculture Series, Agronomy Series, Horticulture Series, Livestock Series, Pest Management Series, Soil and Fertility Series, Marketing & Business Series, Value-Added & Processing Series, Alternative Farming Systems Series, Resource Series, Planting Your Farm's Future Leaflets.
http://www.attra.org/

"Making the Transition to Sustainable Farming -- Fundamentals of Sustainable Agriculture", Appropriate Technology Transfer for Rural Areas (ATTRA). A lot of sensible advice here for kicking the chemicals habit. "Sustainable farming is a management-intensive method of growing crops at a profit while concurrently minimizing negative impact on the environment, improving soil health, increasing biological diversity, and controlling pests. Sustainable agriculture is dependent on a whole-system approach having as its focus the long-term health of the land. As such, it concentrates on long-term solutions to problems instead of short-term treatment of symptoms. One result of such a strategy is that use of agricultural chemicals and similar inputs is reduced, though not necessarily eliminated. As a consequence, the land develops diversity and resiliency that further reduce the need for agricultural chemicals." Covers Planning and Decision Making, Rotations and Cover Crops, Developing a Cropping Mix, The Important of Sod in Rotation, Cover Crops & Green Manures, Composts, Manures and Fertilizers, Weed and Pest Management, Key Ideas for Transition, References.

http://www.attra.org/attra-pub/trans.html

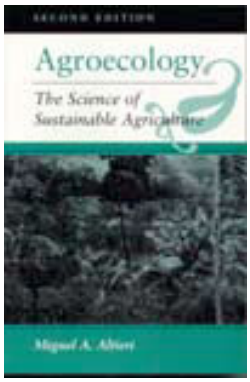
"Biodynamic Farming & Compost Preparation -- Alternative Farming Systems Guide" from Appropriate Technology Transfer for Rural Areas (ATTRA), by Steve Diver, ATTRA Technical Specialist. Biodynamic agriculture is an advanced organic farming system that is gaining increasing attention for its emphasis on food quality and soil health. Good overview of Biodynamics -- what it is, how it differs from other organic systems, how it works, with an interesting set of appendices comparing the Biodynamics paradigm with other farming systems: traditional, organic and conventional. Contacts, resources, further reading.
http://www.attra.org/attra-pub/biodynamic.html

"Introduction to Permaculture: Concepts and Resources -- Alternative Farming Systems" from Appropriate Technology Transfer for Rural Areas (ATTRA), by Steve Diver, ATTRA Technical Specialist. A central theme in permaculture is the design of ecological landscapes that produce food. But permaculture entails more than just food production. Permaculture design concepts are applicable to urban as well as rural settings, and are appropriate for single households as well as whole farms and villages. This is a good introduction to permaculture, what it means and how to use it -- it was formerly The Permaculture FAQ.
http://www.attra.org/attra-pub/perma.html

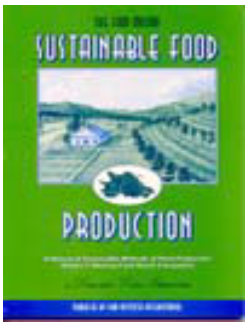
International Ag-Sieve was published by Rodale's International program from 1988 to 1995. Good resource on sustainable development in the Third World, packed with reports and feedback from the field. Issues focused on vermiculture, rice, extension methodologies, animal husbandry, agroforestry, women in agriculture, urban gardens, IPM (integrated pest management), soil amendments, seed saving and biodiversity, ancient farming, training, pastoral, aquaculture, water, bio-control, livestock, post-harvest, composting, legumes/green manures, biocontrol, semi-arid agriculture, cassava/root crops. Back issues are available for US$3 per issue, $1 each for more than six issues, the whole set of 36 issues for $35. Now published in book form, includes articles on green manure, agro-forestry, irrigation, biological pest control, erosion and more -- 26 assorted articles, from 1989 to 1995. From Rodale Institute Bookstore:
http://rodaleinstitute.org/bookstore/products/farm_books/9.html

Agrodok series of booklets, published by Agromisa Foundation, a Dutch NGO. Popular series of concise 30-80-page booklets on small-scale and sustainable tropical agriculture. Titles include Preparation and Use of Compost, Soil Fertility, Green Manuring and other Forms of Soil Improvement in the Tropics, Erosion Control in the Tropics, Water Harvesting and Soil Moisture Conservation, Fruit Growing in the Tropics, The Vegetable Garden in the Tropics, Agroforestry, Urban Agriculture, Natural Management of Crop Pests and Diseases. Livestock production: Pigs, Poultry, Goat, Dairy Cattle, Freshwater Fish, Rabbit, Duck,

Beekeeping, Hatching Eggs. Also Preservation of Foods series. In English and French; some also in Spanish and Portuguese. Available free to African (excluding Mediterranean), Caribbean, and Pacific countries for agriculture or rural development workers. Order form online: http://www.antenna.nl/~agromisa/agrodok/titles.html



"Agroecology: The Science of Sustainable Agriculture" by Miguel A. Altieri, 1987, second edition, 1995
Key principles of sustainable agriculture and management systems that really work. Case studies and research results from around the world. "Agroecology encourages researchers to tap into farmers' knowledge and skills and to identify the unlimited potential of assembling biodiversity to create beneficial synergisms that provide agroecosystems with an innate state of natural stability. Sustainable yield in the agroecosystem derives from the proper balance of crops, soils, nutrients, sunlight, moisture, and other coexisting organisms. The agroecosystem is productive and healthy when these balanced and rich growing conditions prevail and when crop plants remain resilient to tolerate stress and adversity. If the cause of disease, pests, soil degradation, is understood as imbalance, then the goal of the agroecological treatment is to recover balance. In agroecology, biodiversification is the primary technique to evoke self-regulation and sustainability." From ECHO's Global Bookstore: http://echonet.org/shopsite_sc/store/html/Agroecology.html



"Sustainable Food Production" by Don & Lois Subkoviak, 1995, SAND Institutes, International
A manual of sustainable methods of plant production to help meet food needs everywhere. Organic food production, biointensive gardening, no-till, Asian natural farming, composting, natural insect control, crop selection and planting guides, challenges to tropical food production, suggested crops for specific climates, and more. From ECHO's Global Bookstore: http://echonet.org/shopsite_sc/store/html/SustainableFoodProduction.html

Sustainable Farming Connection has resources on cover crops, grazing, pastured poultry, soil health, weed management, compost & manure, grain and beans, growing for market, high-value farming, on-farm energy, livestock, agroforestry. Site search, links, news & events, discussion groups
http://www.ibiblio.org/farming-connection/

USDA's **Sustainable Agriculture Research and Education** (SARE) program offers 10 online "tip sheets" listing free and low-cost resources on improving soil quality, weed and pest control, marketing, organic production, low-cost livestock systems, trees and other topics. The tip sheets tell producers how to obtain books, bulletins and access

web sites for useful information.
http://www.sare.org/publications/index.htm#bulletins

The **SANET-mg Discussion Group** on sustainable agriculture was initiated in 1991. Subscribe online, archives:
http://lists.sare.org/archives/sanet-mg.html
Or send a message to:
listserv@sare.org
In the BODY of the message type only:
subscribe sanet-mg Full Name
Leave the subject line blank and type the message exactly.
Search the SANET-MG archives
http://lists.ifas.ufl.edu/cgi-bin/wa.exe?S1=sanet-mg
Search archives prior to July 2000
http://www.sare.org/sanet-mg/archives/hypermail.html

See also Appropriate technology agriculture resources

Small farm resources

Back to the land -- a 140-year trend
Small farms
Organics
Soil management
Sustainable farming
General
Food storage and preservation
Useful databases

Small farms

Small farm resources
Community-supported farms
Farming with trees
Farming with animals
Pasture
Pigs for small farms
Poultry for small farms
Aquaculture for small farms
Composting for small farms
Controlling weeds and pests

Small farms library

City farms

Organic gardening

Building a square foot garden
Plant spacing guides
No ground? Use containers
When to sow what
Seeds
Garden pond
Gardening resources

Composting

Making compost
Composting resources
Composting indoors
Vermicomposting
Humanure
Composting for small farms

Community development | Rural development
City farms | Organic gardening | Composting | **Small farms** | Biofuel | Solar box cookers
Trees, soil and water | Seeds of the world | Appropriate technology | Project vehicles

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Small farms library
City farms
Organic gardening
Composting
Small farms
- Introduction
- Sustainable farming
- Small farms fit
- References

Small farm resources
Back to the land
Small farms
Organics
Soil management
Sustainable farming
General resources
Food storage and preservation
Useful databases
Community-supported farms
Farming with trees
- Agroforestry
- Bamboo
- Resources

Farming with animals
- Introduction
- Livestock resources
- Cattle
- Sheep
- General
- Draft animals

Small farm resources

General

ECHO -- Educational Concerns for Hunger Organization -- is a non-profit, Christian organization dedicated to the fight against world hunger. The focus is on subsistence tropical agriculture, but this is a great resource for small farmers everywhere, or anyone with a garden. Excellent series of 40 technical notes -- broad topics and specific crops, from beehives in the tropics to organic neem pest control. ECHO Development Notes (EDN) is a technical networking bulletin on tropical agriculture, techniques, plants, resources, to improve food production in the tropics. Full text online. ECHO seed bank of tropical food, fuel, and soil-improving plants -- supplies seed of useful plants in small trial packets for experimentation in the field, seed catalog of unusual garden vegetables for sale (North America). ECHO Canada is a sister organization founded for and by Canadians. Links to websites with useful information. Site search.
http://www.echonet.org/

ECHO Online Global Bookstore has hundreds of selected titles, many hard to find, with cover images, descriptions, TOCs and notes, often including the preface or introduction. Agriculture, gardening, agroforestry, pest control, community development, health and nutrition, appropriate technology and animal production, and a lot more than that. Good selection. Order online.
http://echonet.org/shopsite_sc/store/html/index.html

Mother Earth News Online -- best stories over 30 years of getting back to the land (online), current issue, bookshelf, site search. Back fence -- bulletin boards; Ask Mother -- ask the experts questions "on anything under the sun". Subscribe online. (Not the same as the original Mother Earth News of the 70s and 80s.)
http://www.motherearthnews.com/

"Gardening The Arid Land" by Robert Gerard, 1997
Gerard has been market gardening in the southern New Mexican desert for more than 10 years. He provides knowledgeable information for both market and home gardeners producing vegetables in hot, dry climates. Gerard's methods are in harmony with the surrounding desert, using minimal water and preserving native species. All the materials and techniques are accessible to gardeners with minimal resources. Four major sections: the desert, the soil, the water, the plants. Order from Robert Gerard for $8.95 PPD at 441 Paseo Real, Chaparral, NM 88021. From Fertile Ground Books:
http://www.agaccess.com/cgi-bin/webc.cgi/~fg/st_prod.html?p_prodid=BPB001&sid=22zsARv

Growers' Connection: Books & online resources for small farm

Pasture
- Introduction
- Pasture resources
- Silage

Pigs for small farms
- Why pigs have snouts
- Raising pigs on soil in Japan
- Lady Eve's pigs
- Pigs on pasture
- Pig resources

Poultry for small farms
- Muscovy ducks
- Khaki Campbell ducks
- Chickens
- Geese
- Rabbits
- Guineafowl
- General tips
- High-protein poultry feed from thin air
- Poultry as unpaid labour
- They're not pets
- Doing it

Poultry resources

Aquaculture for small farms
- Introduction
- Aquaculture resources

Composting for small farms
- Foundation
- On-farm composting resources

Controlling weeds and pests
- Weeds
- Weed control resources
- Insect pests
- No pesticides
- Insect control resources

Home

What people are saying about us

About Handmade Projects

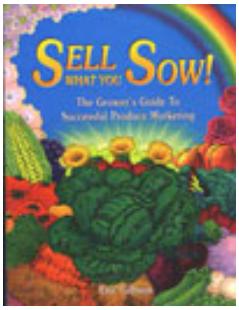
Sitemap (text only)

Projects

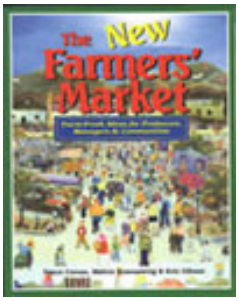
Community development
- Why we're doing this

Rural development
- Fixing what's broken

marketing and farmers' markets, with links to a wide variety of small farm and sustainable agriculture topics.
http://www.nwpub.net/



"Sell What You Sow! The Grower's Guide To Successful Produce Marketing", by Eric Gibson, 1993, New World Publishing, ISBN 0963281402
This how-to book that reveals the tricks of the trade from master marketers around the US. High-value produce marketing for farmers and market gardeners, hands-on information, practical, how-to guidance on selling what you grow and making profits from produce. "Far-and-away the outstanding farm produce marketing text. If you're trying to sell what you grow, this book will quickly pay for itself" -- Small Farmer's Journal.
http://www.nwpub.net/swys.html



"The New Farmers' Market" by Vance Corum, Marcie Rosenzweig & Eric Gibson, 2001, New World Publishing; ISBN: 0963281429
If you want to succeed at farmers' markets in the US, this is the book for you. A "must have" for farmers' market sellers, managers, market planners, and farmers' market community. "Finally, a really good book on farmers' markets!" -- Growing For Market newsletter.
http://www.nwpub.net/tnfm.html

"Backyard Market Gardening: The Entrepreneur's Guide to Selling What You Grow" by Andrew W. Lee, Good Earth, 1995, 0-964648-0-5
Market gardening with vegetables, fruits, flowers, herbs and small livestock in your backyard. Marketing advice, compares different market strategies, guide for newcomers to organic gardening, and a good read too. Not just a dull how-to book. From Rodale Institute Bookstore:
http://rodaleinstitute.org/bookstore/products/farm_books/2.html

"Small Scale Aquaculture: A Guide to Backyard Fish Farming" by Steven D. Van Gorder, 1992, Rodale Institute, ISBN 0-9677732-0-2
Details and plans on how to raise, harvest, prepare, and store over 100lbs of fish in five months. This system is the result of eight years of research at the Rodale Research Center. A simple and efficient way to produce your own fish on a scale appropriate for a self-sustaining household. Makes home aquaculture as practical as gardening for providing healthy food for a family. Features an ecologically sound recirculating system designed for low energy and low water use made from readily available materials. From Rodale Institute Bookstore:
http://rodaleinstitute.org/bookstore/products/farm_books/3.html

City farms
Edible cities
Organic gardening
Everyone can grow their own food
Composting
The Wheel of Life
Small farms
The way forward
Biofuels
Fuel for the future
Solar box cookers
Sun power saves lives and trees
Trees, soil and water
Healthcare for mountains
Seeds of the world
No seeds, no food
Appropriate technology
What works and fits
Project vehicles
The workhorses

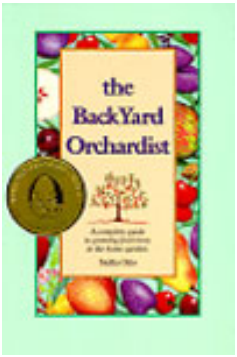
Internet
Why it really matters
Internet interaction
Finding your way

Schools projects
Introduction
Biofuels
Solar box cookers
Backpack stove
PicoTurbine
Low-tech radio
What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox
School gardens
School composting
Trees and forests
The Beach House fish pond
HOMeR
Eco-footprint

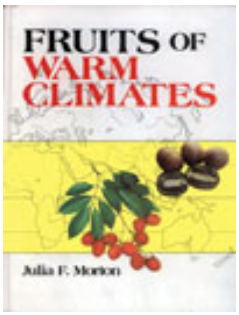
"On-Farm Fish Culture", Agrodok No. 21, 1998, Agromisa Foundation
Crops or animal husbandry can easily be integrated with fish culture, with total production higher and more efficient than farms which haven't been integrated. Step by step strategy: principles of integrated fish culture and the use of plant material as fish feed and/or fertilizer, factors influencing the biological system in a fish pond, integration of fish culture with rice culture or several kinds of livestock production (pigs, poultry, ducks and geese, other livestock), many examples of possible combinations, by-products use, animal manure, using slurry from the pond as fertilizer for crops.
http://www.antenna.nl/~agromisa/agrodok/ad21.html

"Small-Scale Freshwater Fish Farming", Agrodok No. 15, 1996, Agromisa Foundation
Basic information for beginners. Principles of fish farming, site selection and choice of fish farm type. Detailed description of how to set up a small-scale fish farm for subsistence to provide daily protein requirements. Fish farming practises, choice of species, nutrition, health, reproduction, harvesting. Pond construction (appendix) and maintenance. Focus is on carp, tilapia, catfish.
http://www.antenna.nl/~agromisa/agrodok/ad15.html

See **Aquaculture for small farms: Aquaculture resources**



"The Backyard Orchardist: A Complete Guide to Growing Fruit Trees in the Home Garden" by Stella Otto. Revised edition 1995, Otto Graphics, ISBN 0963452037
Step-by-step guidance from a true expert on how to start your orchard -- planning, soil, tree selection for your climate, planting, pruning, pest management, harvesting and storing, everything you need to know. From Powell's Books:
http://www.powells.com/biblio/126200-126400/0963452037.html
From Chelsea Green:
http://www.chelseagreen.com/DP/Otto/BYOrchardist.htm



"Fruits of Warm Climates" by Julia F. Morton, ISBN: 0-9610184-1-0
Julia F. Morton is Research Professor of Biology and Director of the Morton Collectanea, University of Miami, a research and information center devoted to economic botany. Covers 124 species, with an extensive bibliography; the entry for each species is a minor essay, with detailed treatment under Description, Origin and Distribution, Varieties, Climate, Soil, Propagation, Culture, Keeping Quality, Pests and Diseases, Food Uses, Other Uses. The approach is global -- Uses, for instance, covers the practices of traditional peoples throughout the world, including medical uses. Ms Morton provides a real wealth of

School and youth programs on the Web
Education resources on the Web
Children's poetry

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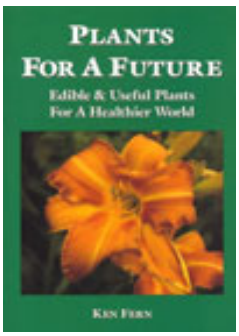
To Midori Hiraga
midori@journeytoforever.org
Homepage
http://journeytoforever.org/

Handmade Projects
Ichijima
Japan

information from her long experience of the subject. With photographs. Full text online:
http://www.hort.purdue.edu/newcrop/morton/index.html

"The Complete Book of Edible Landscaping" by Rosalind Creasy, 1982, Sierra Club, ISBN 0871562782
Thorough treatment, practical, how-to advice from a seasoned landscape designer and consultant, well-illustrated. Energy, water and soil-saving techniques for different regions. Includes a 160-page encyclopaedia of edible plants with cultural details, landscaping, culinary uses, sources and recipes. Large list of plant and seed suppliers. "Head and shoulders above the rest" of the books on this subject, says a master gardener. From the Sierra Club:
http://www.sierraclub.org/books/catalog/0871562782.asp

"Cornucopia II -- A Source Book of Edible Plants" by Stephen Facciola, Kampong, ISBN 0962808725
Encyclopaedia of about 3,000 edible plants, alphabetical listing of plant families with 300 pages describing 7,000 varieties, especially traditional and heirloom varieties, and promising new releases. Habitat, origin, cultivation, preparation, uses modern and ancient, and 1,300 sources for seed, plants and rootstock, produce and other foodstuffs. In addition to common and botanical name cross-referencing there is an index of plants listed by use and edible parts. Wonderful work of scholarship. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/CornucopiaII.html



"Plants for a Future: Edible and Useful Plants for a Healthier World" by Ken Fern, 2000, Permanent Publications, ISBN 1856230112
The way we currently produce our food is damaging both to ourselves and our planet. We need to create gardens, woodlands and farms which are in harmony with nature. What we need is to discover and grow a wide variety of easily grown perennial and self-seeding annuals which provide delicious and healthy food, or are useful in other ways. Describing plants such as these, native to Britain and Europe and from temperate areas around the world, this book includes those suitable for: the ornamental garden, the edible lawn, shade, ponds, walls, hedges, agroforestry and conservation. Packed with information, personal anecdote and detailed appendices and indexes, this pioneering book takes gardening, conservation and ecology into a new dimension. "Ken Fern leads us through a garden of improbable delights -- cold climate yams five feet long, edible fuschia fruits, trees laden with delicious berries all through the winter, leaves and flowers with the most subtle and astonishing flavours. It is hard to over-estimate the importance and likely impact of this book. The result of an insatiable curiosity and years of painstaking research, this book is comparable in stature only to the works of

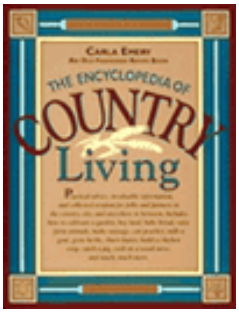
Evelyn and Culpeper." -- George Monbiot, The Guardian. Order from Plants For A Future:
http://www.comp.leeds.ac.uk/pfaf/book.html
See the Plants For A Future online database

"Lost Crops of Africa: Volume I: Grains" by Noel Vietmeyer, 1996, National Academy Press, ISBN 0309049903
Africa has more native cereals than any other continent. It has its own species of rice, as well as finger millet, fonio, pearl millet, sorghum, tef, guinea millet, and several dozen wild cereals whose grains are eaten from time to time. This is a food heritage that has fed people for generation after generation stretching back to the origins of mankind. It is also a local upon which a sound food future might be built. But this legacy of genetic wealth has largely been bypassed in modern times. The "lost crops" can help provide food security in their native areas, which include many parts of Africa threatened with hunger. At the same time maintaining the diversity of these ancient crops will protect options for the rest of the world to use. Full text online at the National Academy Press:
http://www.nap.edu/books/0309049903/html/
From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/LostCropsAfrica.html

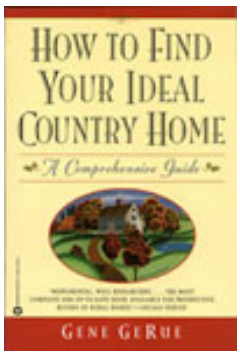
California Rare Fruit Growers (CRFG) is the largest amateur fruit-growing organization in the world. Fruit Facts online -- botanical identification, plant description and culture notes, characteristics of cultivars for 43 fruit varieties -- Common Names, Origin, Species, Related species, Adaptation; Description: Growth Habit, Foliage, Flowers, Fruits; Culture: Location, Soil, Irrigation, Fertilization, Frost Protection, Pruning, Propagation, Pests and Diseases, Fruit Harvest; Cultivars; Further Reading, and a direct link to Index of CRFG Publications, 1969--89. Also The Fruit Gardener magazine, descriptions of 250 rare and unusual edible plants, Seed Bank, the CRFG Fruit List -- Common Name, Genus species, Family, and Fruit Cultural Data, by genus name. Plus a large set of fruit and related links. Exhaustive! Excellent resource.
http://www.crfg.org/

PROSEA stands for **Plant Resources of South-East Asia**, an international program documenting information on South-East Asian plant resources. It covers agriculture, forestry, horticulture and botany and promotes plant resources for sustainable tropical land-use systems. PROSEA has a Network Office in Indonesia coordinating six Country Offices in South-East Asia, and a Publication Office in Wageningen (the Netherlands). The PROSEA Handbook is in 19 parts, on Pulses, Edible fruits and nuts, Dye and tannin-producing plants, Forages, Timber trees, Rattans, Bamboos, Vegetables, Plants yielding non-seed carbohydrates, Cereals, Auxiliary plants, Medicinal and poisonous plants, Spices, and Essential-oil plants. Each has an accompanying

bibliography. The Vegetables volume deals with about 100 important vegetables, cultivated as well as wild species, with descriptions of 125 minor species and a list of 800 species yielding vegetables as a byproduct.
http://www.prosea.nl/



"The Encyclopedia of Country Living -- An Old Fashioned Recipe Book" by Carla Emery, 9th edition 1994, Sasquatch Books, ISBN 0912365951
The homesteaders' bible -- Carla Emery published the first edition herself, more than 25 years ago, and it's since grown into an 800-page illustrated treasure of rural wisdom gleaned over the years from homesteaders and others. It's an all-embracing rural encyclopaedia, the complete resource for self-sufficient living. Grow a garden, milk a cow, catch a pig, pluck a chicken -- everything about food, growing it, storing it and cooking it, including hundreds of recipes, a wealth of practical information, detailed instructions, anecdotes, personal advice, suppliers, catalogs, books and magazines, organizations, how-to, where-to and why-to, and morsels of everything else from the highly personable Ms Emery. From Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=2-0912365951-0
Carla Emery's Web Site:
http://www.carlaemery.com/

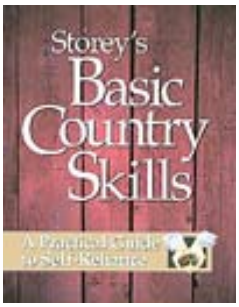


"How to Find Your Ideal Country Home: A Comprehensive Guide", by Gene GeRue, 3rd edition, 1999, Warner Books, ISBN 0446674540
This is what Gene says about his book: "I met too many urban refugees who made a bad move and then had to move two or three times more before they got it right. That hurts, both financially and psychologically, so my purpose is to show you how to get your right place with the first move... There are 32 chapters, each a subject I feel is vital knowledge to help you make your first purchase the right one, so you don't have to uproot yourself and loved ones a second or third time." More about finding out what you want from life and helping you to get it than just getting a good deal on a piece of property. Aimed at the US but good for rural property searches anywhere. Order it from the Country Bookstore at Gene's website:
http://www.ruralize.com/countrybookstore.html

Twenty Essential Steps to Buying Rural Property Right -- "If you cannot afford the book, please read the following", says Gene GeRue, author of "How to Find Your Ideal Country Home":
http://www.ruralize.com/20steps.html

Gene's GeRue's website offers more than just his book, "How to Find Your Ideal Country Home". This is a hub for rural living, with the "Ask & Tell Bumpy Gene" email advice column, useful links, the

Country Bookstore, and "The Complete Guide to Country Living", an "e-book series in progress" -- four books taking shape online. Book One: Designing and building the homestead; Book Two: Plants; Book Three: Animals; Book Four: Community. Gene welcomes contributions.
http://www.ruralize.com/CompleteGuide.html#6



"Basic Country Skills: A Practical Guide to Self-Reliance" by Deborah Burns (Editor), 1999, Storey Books, ISBN 1580172024
"What Country Folk Know that You Don't." Like how to plant a cold and flu garden to make your winter healthier and happier. A manual for everyday survival, whether in town or country, especially on gardening -- more than a third of the 544 pages are devoted to gardening. More than 150 of Storey's expert authors in gardening, building, animal raising, and homesteading share their specialized knowledge and experience. Illustrated step-by-step instructions on how to milk a cow, tap a maple tree, clean a fish, lead a horse, build the best chicken coop -- how to be skilful! Full resource list and a complete index. From Storey Books:
http://www.storeybooks.com/main/special/country_skills/

On-line version of the **Old Farmer's Almanac** that has provided wit, wisdom, weather and much besides since 1792. Cooking, gardening, great editorial and features, Editors' Picks, Picks for Kids, tips & tricks on everything: How to Predict the Weather Using a Pig Spleen, The Truth About Woolly Bears, Three Ways to Hypnotize a Chicken. And so on. Yankee Publishing Inc:
http://www.almanac.com/

Lehman's Non-electric Catalog -- "Serving the Amish and others without electricity with products for simple, self-sufficient living since 1955." Everything you need to go back to the land, from the people who never left it in the first place. Stuff here from all over the world -- German pressure lanterns, Chinese anvils, South African 3-legged cast-iron cooking pots, scythes from Austria, high-quality, built-to-last-forever goods made by local Amish craftsmen, lots of basic, sensible items you just don't find anywhere these days. Order online. Site search.
http://www.lehmans.com/

"Agskills -- A Practical Guide to Farm Skills", Tocal College, NSW, Australia
Learn how to do those hands-on jobs around the farm quickly and correctly. The Agskills series are step-by-step guides to common farm jobs. Agskills are available for beef, sheep, dairy, goats, knots, fencing, trees and pastures, more. From the CB Alexander Agricultural College, NSW Agriculture:
http://www.agric.nsw.gov.au/Agedu/Tocal/catalog.htm

"Drip Irrigation for Every Landscape and All Climates: Helping Your Garden Flourish, While Conserving Water!" by Robert Kourik, Heidi Schmidt (illustrator), 1993, Metamorphic, ISBN 0961584823
How to plan and set up a drip system. Kourik has been installing drip systems and advising people about them for many years. His familiarity with the intricacies of these tricky arrangements lets him cut through the jargon and mystery. Clearly illustrated, the definitive work on drip irrigation. From Open Communications:
http://www.NetStoreUSA.com/hrbooks/096/0961584823.shtml

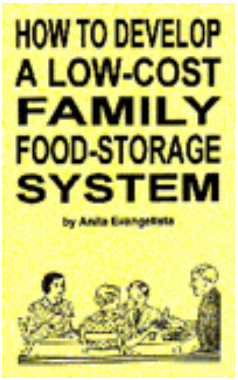
The Drip Store -- Online Source for Drip Irrigation, worldwide shipping: catalog, advice by email, bookstore, and online web forum on drip irrigation (lots of information in the message archive):
http://www.dripirrigation.com/cgi-bin/SoftCart.exe/dripstor/index.html?E+dripstor

Microirrigation Forum -- Microirrigation is the universal term for drip, trickle or microspray irrigation systems. It is a growing technology which has the potential to maximize crop productivity, conserve soil, water and fertilizer resources while protecting the environment. The purpose of this forum is to provide an online niche which focuses on the technical and management aspects of microirrigation systems. The Microirrigation Forum also serves as the home page for Trickle-L, an e-mail discussion list regarding this technology.
http://www.microirrigationforum.com/index.html

Bucket Drip Irrigation Kit -- Chapin Watermatics. The bucket drip irrigation kit is an excellent tool for growing a vegetable garden with minimal amounts of water and labor. With the kit comes 100 feet of drip tape, a filter plug and all the fittings and hoses to connect the tape to the bucket. Bucket not included. (Picture shows two bucket kits.) From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/BucketeDripKit.html

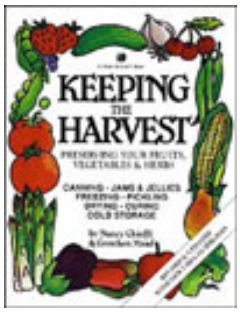
"**Bucket Kit Watering vs Hand Watering**" -- Chapin Third World Projects, Chapin Watermatics. Bucket Kits are now being used in many countries to help the poorest of the poor to grow vegetables when they have no rain.The recommendation is to use 10 gallons of water daily for two 50-foot rows of vegetables. The water often has to be carried for a mile or two. This is a report on trials to determine if 10 gallons is enough water to grow a good crop. An identical hand watered bed of vegetables was grown next to the Bucket Kit bed. The same amount of water was applied twice daily to both beds. Both beds produced a good crop, but the total crop in the Bucket Kit bed had a 24.3% yield increase over the total crop in the hand watered bed.
http://www.hydrosource.com/web_clp/971101/chap2.htm

Food storage and preservation



"How to Develop a Low-Cost Family Food-Storage System" by Anita Evangelista, 1995, LoomPanics Unlimited, ISBN 0966693205
Determine your storage needs, find sources of low-cost bulk foods, choose suitable preservation methods. For better self-sufficiency and just-in-case, and cut your food bills by half while you're at it.
From Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=4-0966693205-0
From Safety Central:
http://www.safetycentral.com/noname1.html

"Making the Best of Basics" by James Talmage Stevens, 10th edition, 1997, Gold Leaf, ISBN 1882723252
How to live on your own resources for up to a year, regardless. This was probably the first book on the subject, and probably still the most comprehensive -- 350,000 copies sold, and updated with a hundred new pages of charts, tables and information. "Store what you eat, eat what you store, use it or lose it." Thorough. From Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=7-1882723252-0



"Keeping the Harvest" by Nancy Chioffi & Gretchen Mead, 1991, Storey Books, ISBN 0882666509
Canning, freezing, drying, preserving and storing -- simple home-preserving techniques to stretch out the fruit and vegetable harvest throughout the year. A reference for thousands of gardeners and cooks since 1976, now updated with new techniques, equipment, and USDA guidelines for home preserving. Fruits and vegetables listed alphabetically with recommendations for preserving them, with reference charts, recipes, troubleshooting tips.
From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/KeepingHarvest.html

"Root Cellaring: Natural Cold Storage of Fruits and Vegetables" by Mike and Nancy Bubel, 2nd edition, 1991, Storey Books, ISBN 0882667033
A complete guide to building and using root cellars, indoors and out, big or small, plain or fancy. Root cellaring is a simple, energy-saving way to keep food fresh all year. Explains building and using different types of root cellars and which vegetables and fruits store best. Cheap, effective, low-tech ways

to store the harvest, storage requirements for nearly 100 home garden crops, dozens of delicious recipes. Variety of root cellar plans with illustrations and drawings for nearly any situation. From Storey Books: http://www.storeybooks.com/new_sell_sheets/703-3.html

Agriculture databases and search engines

AgriSurf! -- "The Farmers Search Engine" -- not a search engine but a large and well-organized directory with a site-search engine. 15,327 agriculture sites listed, in more than 30 categories. Search the site, choose a country, or browse the directories, also in sub-categories such as Companies, Discussion, Indexes & Links, Publications, Searchable Database, etc. Sites listed with descriptions, country identifier flags, latest update, speed and reliability ratings, contact address tag listing postal, email and website addresses, phone and fax. Comprehensive -- very useful!
http://www.agrisurf.com/

Bill Drew's **"Not Just Cows -- Guide to Agriculture and Agricultural Resources on the Internet and the World Wide Web"** has been running since 1992, and on the Web since 1994. Site search engine, Latest Agriculture News, Libraries, Databases, Discussion Groups, E-Journals, USENET Newsgroups, Commercial and Non-commercial WWW Sites, Associations, etc.
http://www1.morrisville.edu/~drewwe/njc/

The **New Crop Resource Online Program** at Purdue University, includes CropSEARCH -- a keyword search engine to access crop information, CropINDEX -- a list of scientific and common names of crops for information access, CropREFERENCE -- books and manuals on crops, Aromatic-MedicinalPLANTS -- a guide to aromatic & medicinal plants, culinary herbs & spices, NewCrop LISTSERV -- an interactive bulletin board for queries, discussion, and information on crops, and much more. Easy access to a huge set of resources on crops new and old, trees, plants of all kinds. "The most comprehensive library and compilation of new and alternative crop information available on the web." Very useful indeed.
http://www.hort.purdue.edu/newcrop/

"New Crops: Solutions for Global Problems" -- excellent article by Noel Vietmeyer of the New Crops project. "Consider the following. In Africa, where the hunger problem is concentrated, there are actually 2,000 species of native food plants. Both there and in the rest of the tropics, the region where malnutrition is severest, can be found 3,000 different fruits as well as over 1,000 vegetables. In the lands where deforestation is so destructive are to be found over 20,000

trees, some of them extremely fast growing. In the desertifying regions can be found many useful drought-tolerant plants -- I don't know how many, but it runs into the hundreds. Despite the existence of all this herbaceous heritage, hardly any tropical plant is being employed to full advantage to relieve the pervasive problems. Of Africa's 2,000 food plants, only sorghum gets major research. Of the 3,000 fruits, only banana and pineapple get solid global support, and again much of the effort is aimed at helping the rich rather than the needy. Of the 20,000 tropical trees, only a handful are undergoing global advancement. That the bulk of useful tropical biodiversity is underexploited is one of the glaring oversights of this era. The creation of more crops and the support for new-croppers is of global importance." Read on!
http://newcrop.hort.purdue.edu/newcrop/proceedings1996/V3-002.html

Plants For A Future -- Database Search has a wide variety of powerful searches of very large plant resources. Search by Name (common or family), Edible, Medicinal or Other Use, Native Area, Habitat, word search, Latin names. You can download the database for your own use.
http://www.ibiblio.org/pfaf/D_search.html

AgNIC (Agriculture Network Information Center) is a distributed network that provides access to agriculture-related information, subject area experts, and other resources. It was established by an alliance of the National Agricultural Library, land-grant universities, and other organizations committed to facilitating public access to agricultural and related information. AgDB is a database directory of quality agriculture-related databases, datasets, and information systems. It describes and links to more than 1,100 information resources, ranging from "technical" to "practical".
http://www.agnic.org/

Dr. James Duke's **Phytochemical and Ethnobotanical Databases** -- search for Chemicals and activities in a particular plant, High concentration chemicals, Chemicals with one activity, Ethnobotanical uses. Many different search options and different resources to search. Hosted by the USDA's Agricultural Research Service (ARS).
http://www.ars-grin.gov/duke/

Web-agri, "the smart farming site", is the first "real agricultural search engine" (not a searchable directory site). Search for information on more than 600,000 agricultural web pages.
http://www.web-agri.com

Poisonous Plants at Cornell University's Animal Science Department includes plant images and information on botany, chemistry, toxicology, diagnosis and prevention, linked to related resources. Database search.
http://www.ansci.cornell.edu/plants/plants.html

The Gatherer Plant Use Multiple Database Search Engine -- searches a collection of plant-use databases simultaneously, or provides direct links to each, with a description. Includes most, but not all, of the best online resources. Works best with Latin names.
http://www.Kippewa-Gardens.com/cgi-bin/Gatherer.pl

See also Appropriate technology agriculture resources

Small farm resources

Back to the land -- a 140-year trend
Small farms
Organics
Soil management
Sustainable farming
General
Food storage and preservation
Useful databases

Small farms

Small farm resources
Community-supported farms
Farming with trees
Farming with animals
Pasture
Pigs for small farms
Poultry for small farms
Aquaculture for small farms
Composting for small farms
Controlling weeds and pests

Small farms library

City farms

Organic gardening

Building a square foot garden
Plant spacing guides
No ground? Use containers
When to sow what
Seeds
Garden pond
Gardening resources

Composting

Making compost

Composting resources
Composting indoors
Vermicomposting
Humanure
Composting for small farms

Community development | Rural development
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Farming with animals

Community-supported farms

Community Supported Agriculture (CSA) had its roots in Japan more than 30 years ago, where a group of women concerned about increasing food imports and a falling farming population set up direct consumer links with local farms.

(CSA North America)

The idea spread to Europe and later to the US -- there are now more than 1,000 CSA farms in the US and Canada, serving more than 100,000 families.

But most Americans still have no idea where their food comes from: in fact up to 90% of it comes from beyond the state borders, travelling an average of 1,300 miles before it reaches their dinner tables. The same applies to most city dwellers, especially in the industrialized countries.

In the US as elsewhere more people want to know more about the food they eat, and this is opening up new opportunities for CSA, and a new type of market for small farmers, especially those using sustainable systems, for these are consumers who care.

Consumers pay in advance, sharing the farmers' risks, and often the labour on the farm, and sharing the benefits: top-quality, fresh food at below-retail prices, and a fresh connection with the land -- which most value more than the food-price savings.

Member groups range from a few dozen to hundreds, paying membership fees between $200 and $500 for 5-10 pounds of food per week. Most of the farms are small, averaging about 35 acres.

A major plus of the CSA arrangement is that it returns farming and food to the community-level where it belongs. It's an infinitely variable arrangement that can be worked out and adjusted through practise until it suits everyone concerned.

No CSA group in your area? Why not start one?

Resources

- Introduction
- Livestock resources
- Cattle
- Sheep
- General
- Draft animals

Pasture

- Introduction
- Pasture resources
- Silage

Pigs for small farms

- Why pigs have snouts
- Raising pigs on soil in Japan
- Lady Eve's pigs
- Pigs on pasture
- Pig resources

Poultry for small farms

- Muscovy ducks
- Khaki Campbell ducks
- Chickens
- Geese
- Rabbits
- Guineafowl
- General tips
- High-protein poultry feed from thin air
- Poultry as unpaid labour
- They're not pets
- Doing it

Poultry resources

Aquaculture for small farms

- Introduction
- Aquaculture resources

Composting for small farms

- Foundation
- On-farm composting resources

Controlling weeds and pests

- Weeds
- Weed control resources
- Insect pests
- No pesticides
- Insect control resources

Home

What people are saying about us

About Handmade Projects

"Sharing the Harvest -- A Guide to Community Supported Agriculture" by Elizabeth Henderson, 1999, Chelsea Green, ISBN 1890132233
An indictment of the current food production and distribution system, and a solution, via Community Supported Agriculture -- the farm feeds the people, the people support the farm and share in the inherent risks and potential bounty. Setting up a CSA, with options and cautions for each step, with the best examples of CSA farms the authors could find. Nuts and bolts, money matters, legalities, growing, harvesting, distributing, how to include low-income members, community food security. References and a resource list. Written by a farmer and respected CSA leader and pioneer. From Chelsea Green:
http://www.chelseagreen.com/Sharing/
From Community Bookshelf:
http://bookshelf.ic.org/books/sharing-the-harvest.html

"Community Supported Agriculture -- Business Management Series", Appropriate Technology Transfer for Rural Areas (ATTRA). Community Supported Agriculture (CSA) is both a marketing technique and a way of life. CSAs across the country are helping farmers make ends meet. This publication discusses the basics of CSAs, how they work, how to get started, how to retain shareholders. Reading list, resources, organizations, publications, websites.
http://www.attra.org/attra-pub/csa.html

Community Supported Agriculture (CSA). This US information resource is a cooperative effort between the Cooperative State Research Education and Extension Service (CSREES) and the National Agricultural Library (NAL) of the US Department of Agriculture (USDA). General information, state-by-state listing of CSA farms, CSA resources for farmers, sustainable agriculture resources, nutrition and health, organic recipes, web and other resources, books and recent articles and more.
http://www.nal.usda.gov/afsic/csa/

The **Biodynamic Association** provides a list of all CSAs in the US and Canada. Also has brochure: "Introduction to Community Supported Farms and Farm Supported Communities".
http://www.biodynamics.com/csa.html

Sitemap (text only)

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Why we're doing this
Rural development
Fixing what's broken
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Edible cities
Organic gardening
Everyone can grow their own food
Composting
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The workhorses

Internet
Why it really matters
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Finding your way

Schools projects
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Biofuels
Solar box cookers
Backpack stove
PicoTurbine
Low-tech radio

The **Community Farm Newsletter** -- "A Voice For Community Supported Agriculture": quarterly newsletter for people interested in community supported agriculture ("community shared agriculture" in Canada). A forum for CSA growers, farm members and prospective CSA farmers to explore ideas, techniques, organic farming, small farm preservation, sustainable agriculture. Publishers are CSA farmers Northern Michigan.
http://www.gks.com/TCF/

"What is CSA?" from Community Supported Agriculture of North America at University of Massachusetts Extension. Informative what-is, plus Resource List: publications, periodicals, videos, organizations; Canadian CSA farm listings, US CSA farm listings.
http://www.umass.edu/umext/csa/about.html

CSA-L@prairienet.org email list on Community Supported Agriculture:
http://www.prairienet.org/pcsa/CSA-L/

"Farms of Tomorrow Revisited: Community Supported Farms, Farm Supported Communities" by Trauger M. Groh, revised 1997, Biodynamic Farming and Gardening Association, ISBN 0-938250-13-2
"Farming is everyone's responsibility, and has likewise to be accessible for everyone," says the author. Most people have never met a farmer or seen a potato in the ground. Explains why society needs smaller farms that care for the land and their communities and produce a bounty of healthy produce for the consumer. Ten examples of CSA (Community Supported Agriculture) farms with first-hand information and advice from the farmers themselves. Valuable to anybody interested in the CSA movement in the United States (or the world), or to farmers wishing to start their own CSA program. Helpful appendices on getting started, acquiring land, sample budgets, and typical CSA shares are included. From Powell's Books:
http://www.powells.com/biblio/125000-125200/0938250132.html
From Chelsea Green:
http://www.chelseagreen.com/DP/FarmsTomorrow.htm

What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox
School gardens
School composting
Trees and forests
The Beach House fish pond
HOMeR
Eco-footprint
School and youth programs on the Web
Education resources on the Web
Children's poetry

Contact us

To Keith Addison
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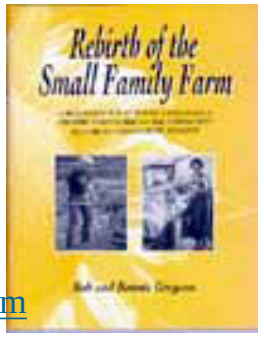
Handmade Projects
Ichijima
Japan



"Rebirth of the Small Family Farm" by Bob and Bonnie Gregson, 1996
"A first-person account of a rewarding second career in Community Supported Agriculture. A great introduction to subscription farming." From Alternatives for Simple Living:
http://www.simpleliving.org/catalog/BuildingComm.html#RebirthoftheSmallFamilyFarm

"Creating a Market -- Getting started in Community Supported Agriculture" by Sarah Milstein, Mother Earth News, Feb/March 1999. Clear view of the CSA option, focus on one farm family's experience, good advice on how to proceed, do's and don'ts. Start small and grow slowly -- plan ahead. And the rewards: "Four or five members are coming up from the city tomorrow to plant garlic with us. It's amazing to me that people are going to take the time and expense to help out because they care about next year. That level of commitment has been very reassuring for us. It makes us step back sometimes and appreciate our farm and what we do."
http://www.motherearthnews.com/gardening/gar172.csa.middle.html

"A Share in the Harvest -- A feasibility study for community supported agriculture", Soil Association, 2001 -- Looks at how community supported agriculture (CSA) can help in the development of local and sustainable food economies. Investigates community involvement in farming around the globe and in a number of established and planned CSA initiatives in England. Eleven case studies.
http://www.soilassociation.org/sa/saweb.nsf/24ffc96e2350a4e680256ab10047def0/661fa3dbd759a0e480256ae200745434?OpenDocument

"A Share in the Harvest -- an action manual for community supported agriculture", Soil Association, 2001 -- A practical guide to support farmers/growers, consumers and activists who wish to develop community supported agriculture (CSA) initiatives. Uses experiences from CSA farms in the UK and overseas and includes information on CSA models, membership, finance and legal issues, land and share issues, grant advice and useful publications.
http://www.soilassociation.org/sa/saweb.nsf/45663f98fc3fd56580256a9300536789/cc3294753eff891a80256b79005e97e6?OpenDocument

National Association of Farmers Markets, UK -- Farmers' Markets are for all kinds of food producers and offer a low-cost entry point for many farmers who have not 'sold direct' before. Farmers'

markets are the embodiment of the availability of home grown foods. They are the British farming industry's most high-profile shop-window. Market guidelines, starting a market, find local markets, and more.
http://www.farmersmarkets.net/

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Farming with animals

Farming with trees

-- "When we develop an agriculture that fits the land, it will become an almost endless vista of green, crop-yielding trees." -- *J. Russell Smith, "Tree Crops: A Permanent Agriculture", 1929*

-- "What are the main principles underlying Nature's agriculture? These can most easily be seen in operation in our woods and forests. Mixed farming is the rule: plants are always found with animals: many species of plants and of animals all live together. In the forest every form of animal life, from mammals to the simplest invertebrates, occurs. The vegetable kingdom exhibits a similar range: there is never any attempt at monoculture: mixed crops and mixed farming are the rule." -- *Sir Albert Howard, "An Agricultural Testament", 1940*. See Nature's agriculture (Go on -- click it! You'll be glad you did.)

-- "The marriage of forestry and farming must be included in all our future agricultural policies." -- *Sir Albert Howard, "Farming and Gardening for Health or Disease (The Soil and Health)", 1945*

-- "In order for humid tropical agriculture to be both highly productive and sustainable, it must imitate the highly productive, millions-of-years-old humid tropical forest" -- *Roland Bunch, "An Odyssey of discovery: principles of agriculture for the humid tropics", ILEIA Newsletter Vol. 11 No. 3 (October 1995): "We Love Weeds"*

-- "Agroforestry is possibly the most self-sustaining and ecologically sound of any agricultural system." -- *Dr. Franklin W. Martin, "Agroforestry Principles", ECHO Technical Note, 1992*

Agroforestry

Agroforestry integrates trees with farming, such as lines of trees with crops growing between them (alley cropping), hedgerows, living fences, windbreaks, pasture trees, woodlots, and many other farming patterns.

There's nothing new about it -- it only seems new because modern industrialized farming ("commodity extraction" rather than farming) has veered so far from true farming practices. The heavy machines and single-crop production lines are

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tree-unfriendly.

A livestock enclosure formed by a living fence of thorny Caesalpinia trees that the livestock won't eat

Previously, many traditional farming systems all over the world integrated trees with crops and livestock, and many continue to do so. The traditional European mixed farm with its crop and livestock rotations over the land was alive with trees, in hedgerows, pastures and woodlots, lining lanes, around homesteads. Such farms are still to be found in many parts of Europe.

Now agroforestry is perhaps the fastest growing sector of the sustainable farming movement, in both the developed countries and the Third World.

Agroforestry increases biodiversity, supports wildlife, provides firewood, fertilizer, forage, food and more, improves the soil, improves the water, benefits the farmers, benefits everyone.

Bamboo

When you've lived in the East for awhile, you begin to wonder how life was ever possible without bamboo. In Hong Kong they still build 50-storey buildings with bamboo scaffolding:

High-rise bamboo scaffolding in Hong Kong...

it's strong, light, and flexible, so it doesn't blow away in typhoons.

On a small farm, bamboo is incredibly useful. Small farmers who depend on it (you soon will) plant at least two varieties. Most varieties flower every 30 years, others every 15, 45, 60, or even 120 years -- always in multiples of 15 years, for some reason. Then it dies back for five years or so -- no bamboo. So you need different varieties.

All bamboo plants of the same variety, wherever they might be in the world, flower on the same day. Just think of that.

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Apart from the poles, bamboo leaves make fine hay with a high protein content. And bamboos are beautiful, and the groves make lovely creakings in the breeze. Its infinity of uses is only limited by the imagination. Rudolf Diesel's first compression ignition motor was inspired by a traditional firemaker tribesmen made from bamboo. One bamboo website lists "Uses of bamboo". It might be easier to list things you can't use it for.
http://kauai.net/bambooweb/bambooa2z.html

... 25 floors up, 10 to go, and no safety harness

Bamboo is not just a tropical plant, there are varieties for most climates -- there are more than a thousand varieties of bamboo (and they've never been crossed, because of their weird flowering habits).

The Overstory #30: Agroforestry (free on-line journal focusing on trees and crops in agroforestry) -- **Bamboos in Agroforestry**
http://www.agroforester.com/overstory/overstory30.html

Bamboo: A Multipurpose Agroforestry Crop by Steve Diver of Appropriate Technology Transfer for Rural Areas (ATTRA) -- excellent information and resources on bamboo agroforestry from ATTRA, particularly in temperate regions.
http://attra.ncat.org/attra-pub/bamboo.html

Bamboo Fact Sheet from the International Network for Bamboo and Rattan (INBAR) -- "A single bamboo clump can produce up to 15 kilometres of usable pole (up to 30 cm in diameter) in its lifetime."
http://www.inbar.int/bamboo.htm
Bamboo and Rattan Information Portal:
http://www.inbar.int/InfoPortal.htm

Bamboo Web
http://www.kauai.net/bambooweb/bamboo.html

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Silkworms in a shoebox
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Eco-footprint

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Bambus-Centrum is a German site, worldwide bamboo links.
http://www.bambus.de/index.html

American Bamboo Society
http://www.americanbamboo.org

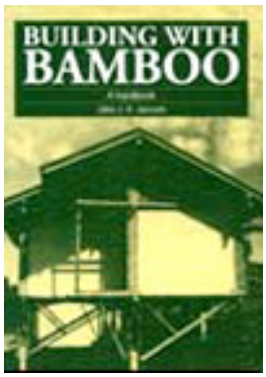
Bamboo Society of Australia
http://www.bamboo.org.au

European Bamboo Society -- links
http://www.bodley.ox.ac.uk/users/djh/ebs/ebsindex.htm

Lewis Bamboo Groves in Alabama has over 80 varieties of cold-hardy bamboo.
http://www.lewisbamboo.com/

Burt Associates says there's a bamboo suited for every climate and has an online MiniGuide to Bamboo with plant descriptions and pictures. Online orders.
http://www.bamboos.com/

jmbamboo Bamboo Nursery -- US-based nursery supplying cold-hardy bamboo for screens, gardens, and landscapes. Most are spreading, evergreen bamboos, ranges in size from tiny groundcovers to towering giants, also rare or hard to find bamboos. Books on bamboo, FAQ, good information on how bamboo grows, planting and growing, controlling bamboo, what to do if it flowers, more.
http://www.jmbamboo.com/



"Building With Bamboo" by Jules J. A. Janssen, 1995
This handbook brings together the practical experience of engineers working in the field, and research programs testing the properties of bamboo. Shows how bamboo has been used in different designs in developing countries and describes the varying properties and uses of different types of bamboo. How bamboo can be harvested, seasoned and jointed to form walls, doors and windows, roofs, floors, ceilings, roof trusses and bridges, and how to weave bamboo. Experiences of Dutch engineers in colonial Indonesia long ago building houses, roads and bridges, combined with similar original English material, plus the results of modem research programs, with the addition of the latest knowledge and a case study from Costa Rica. From

ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/BuildingBamboo.html

Resources

"Tree Crops -- A Permanent Agriculture," by J. Russell Smith, Harcourt-Brace, New York, 1929; Devin-Adair, Connecticut, 1950; Island Press Conservation Classics, 1987, ISBN 0-933289-44-0
Russell Smith was 50 years ahead of his time, writing the basic text on agroforestry long before there was such a thing. He travelled widely and saw it all coming. The best book about trees -- it's inspired generations of environmental activists, including all the leading lights in the movement. Wonderful! Introductory chapters online in the **Small Farms Library**. Buy the book from Island Press:
http://www.islandpress.org/books/Detail.tpl?cart=30831123971221&SKU=0-933280-44-0

Overstory #7: Agroforestry (free on-line journal focusing on trees and crops in agroforestry) -- **"Agroforestry: A way of farming that can work for everyone"**
"There is growing concern throughout the world about the loss of species diversity. Much of the destruction has taken place to make room for human agriculture, particularly pastures, plantations, and other monocultures. Agroforestry systems increase species diversity within farming systems, providing for human needs while supporting wildlife, soil microorganisms, rural communities, farmers, economic interests, watersheds, clean air concerns, biodiversity, and more." Online:
http://www.agroforester.com/overstory/overstory7.html

agroforester.com -- Resource for Tropical Forestry and Agroforestry, based in Hawaii -- Publishes the Overstory free email journal for agroforesters, gardeners and others. Back issues online. Forest management plans, agroforestry plans, tree seedlings, tree seeds and plant inoculants (mycorrhiza and rhizobium), training and education workshops. Free publications: Nitrogen Fixing Tree Start-up Guide, Guide to Orchard Alley Cropping, Multipurpose Windbreaks, Multipurpose Palms, Forest Technology Bulletins, Sheet Mulching, more. Agroforestry links. Site search.
http://www.agroforester.com/

"Agroforestry Principles" by Dr. Franklin W. Martin & Scott Sherman, 1992, ECHO Technical Note -- "Agroforestry is the production of trees and of non-tree crops or animals on the same piece of land. This system of land management is possibly the most self-sustaining and ecologically sound of any agricultural system. Agroforestry systems make maximum use of the land. Every part of the land is considered suitable for plants that are useful. Agroforestry is designed to produce a range of benefits including food, feed, fuels, often fibers, and usually renewed soil fertility. It takes advantage of trees for many uses, to hold the soil, to increase fertility through nitrogen fixation, or through bringing minerals from deep in the soil and depositing them by leaf-fall, to provide shade, construction materials, foods and fuel." Online (Acrobat file):
http://www.echonet.org/tropicalag/technotes/Agrofore.pdf

"Multipurpose Trees", Chapter 4 of "Amaranth to Zai Holes: ideas for growing food under difficult conditions" by ECHO (Educational Concerns for Hunger Organization). An updated compilation of 15 years of the quarterly technical bulletin ECHO Development Notes in book form, online version -- a treasurehouse of practical information for and from the field. This chapter covers Trees in agricultural systems, Multipurpose trees, Fruit and nut species, Working with trees. Excellent resource.
http://www.echonet.org/tropicalag/aztext/azch4.htm

Association for Temperate Agroforestry -- "Agroforestry practises are intentional combinations of trees with crops and/or livestock which involve intensive management of the interactions between the components as an integrated agroecosystem." Alley cropping, windbreaks, riparian buffer strips, silvopasture and forest farming. Agroforestry articles online, links and resources. Publishes the Temperate Agroforester quarterly newsletter -- articles about agroforestry research, demonstration, education, public policy, and government programs, news, events, new publications, Internet resources, networking. Back issue index of articles, order online.
http://web.missouri.edu/~afta/

"Agroforestry", Agrodok No. 16, Agrodok Publications, Agromisa Foundation, 1994, ISBN 90-72746-54-6
Useful guide to agroforestry, offering a variety of options for improving land use. For both humid and arid tropical areas. Describes five methods of agroforestry tree management: living fences, shelterbelts, alley cropping, improved fallow, home

gardens. A chapter on extension gives an idea of the farmer's role and provides support for the design and planning of extension activities. Extensive discussion of the practical implications of agroforestry. Bibliography, glossary and address list of relevant research stations, list of over 300 tree species, per continent, with scientific, English, French and Spanish names. Order from Agromisa:
http://www.agromisa.org/agrodok/ad16.html

"Agroforestry Overview" -- One of the excellent Technical Notes from Appropriate Technology Transfer for Rural Areas (ATTRA) in the US. "Agroforestry is a farming system that integrates annual crops and/or livestock with long-term tree crops. The resulting biological interactions provide multiple benefits, including diversified income sources, increased biological production, better water quality, and improved habitat for both wildlife and humans. Farmers adopt agroforestry practises for two reasons. They want to increase their economic stability and they want to improve their management of natural resources under their care." Clear and thorough treatment, good references, resources and links. Online:
http://www.attra.org/attra-pub/agroforestry.html

Hedgerow intercropping in the Philippines -- Leucaena leucocephala interplanted with beans

FACT Net was an international network of community groups, development workers, tree breeders, researchers, students, and farmers, with 2,000 partners in 100 countries devoted to the use of multipurpose trees to improve the soil, protect the environment, and enhance the well-being of farm families and other land users. Originally the Nitrogen Fixing Tree Association (NFTA), which provided the skills and resources necessary to use nitrogen fixing trees for sustainable agriculture and environmental protection to thousands of people worldwide. FACT Net closed in 1999 after nearly 20 years, the web site is maintained as an on-line resource and for ordering FACT Net publications. FACT Net News online (up to September 1999), large online collection of FACT sheets on multipurpose trees, research reports, field manuals, seed sources, resources and links, Agroforestry Practises Slide Show (20 slides, with explanatory notes).
http://www.winrock.org/forestry/factnet.htm

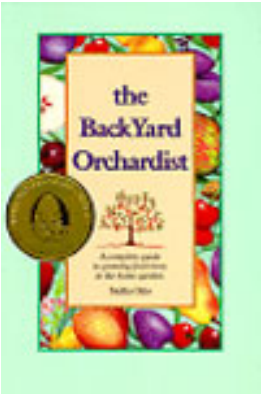
USDA National Agroforestry Center -- A partnership of the USDA Forest Service, Rocky Mountain Research Station and the USDA Natural Resources Conversation Service to promote agroforestry development. Technology Transfer & Applications, Research & Development, International Technology Exchange. Publications, information and resources.
http://www.unl.edu/nac/
"About Agroforestry" has sets of links to useful fact sheets, how-to's, references and agroforestry resources in the US (temperate agroforestry): Windbreaks, Riparian Forest Buffers, Alley Cropping, Silvopasture, Forest Farming, Special Applications.
http://www.unl.edu/nac/agroforestry.html

"Forest Farming: Towards a solution to problems of world hunger and conservation" by J. Sholto Douglas & Robert de J. Hart, Rodale Press, 1978, Intermediate Technology Publications, 1984, ISBN 0946688303
The integration of tree and other farming establishes a sounder ecological balance and greater productivity of food and materials for clothing, fuel and shelter. Only 8-10% of the world's surface is currently used for food production, but planting of crop-yielding trees could raise that figure to 75%. The book suggests planting and cropping methods and a range of potentially useful trees. Foreword by Fritz Schumacher ("Small is Beautiful"). From ECHO's global bookstore:
http://echonet.org/shopsite_sc/store/html/product42.html

"Live Fences" by Stefan D. Cherry & Erick C.M. Fernandes, Dept. of Soil, Crop & Atmospheric Sciences, Cornell University -- Resource-poor food crop farmers can't afford barbed wire for fences, and more and more farmers are using trees and shrubs to form dense, often thorny, hedges to protect their crops. These live fences control the movement of animals and people, and provide many extra benefits you don't get from barbed wire: fuelwood, fodder and food, wind breaks, soil enrichment and more, depending on the species. Online:
http://ppathw3.cals.cornell.edu/mba_project/livefence.html
See also Live Fences, Overstory #38 (free on-line journal focusing on trees and crops in agroforestry)
http://www.agroforester.com/overstory/overstory38.html

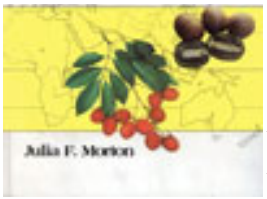
"The Living Fence -- Its Role on the Small Farm" by Dr. Franklin W. Martin, 1991, ECHO Technical Note -- Small farms need fences, and fences of living poles reduce costs, last much longer and have many benefits. They are widely used in a wide range of ecological situations, from very dry to rain forest conditions. Suitable plant materials are available for almost all ecological conditions. Other benefits: firewood, fertilizer, feed, food, fibers, shade, construction materials, medicines, windbreaks. Includes tables of species suitable for living fences. Online (Acrobat file):
http://www.echonet.org/tropicalag/technotes/LivingFe.PDF

California Rare Fruit Growers (CRFG) is the largest amateur fruit-growing organization in the world. Fruit Facts online -- botanical identification, plant description and culture notes, characteristics of cultivars for 43 fruit varieties -- Common Names, Origin, Species, Related species, Adaptation; Description: Growth Habit, Foliage, Flowers, Fruits; Culture: Location, Soil, Irrigation, Fertilization, Frost Protection, Pruning, Propagation, Pests and Diseases, Fruit Harvest; Cultivars; Further Reading, and a direct link to Index of CRFG Publications, 1969--89. Also The Fruit Gardener magazine, descriptions of 250 rare and unusual edible plants, Seed Bank, the CRFG Fruit List -- Common Name, Genus species, Family, and Fruit Cultural Data, by genus name. Plus a large set of fruit and related links. Exhaustive! Excellent resource.
http://www.crfg.org/



"The Backyard Orchardist: A Complete Guide to Growing Fruit Trees in the Home Garden" by Stella Otto. revised edition 1995, Otto Graphics, ISBN 0963452037
Step-by-step guidance from a true expert on how to start your orchard -- planning, soil, tree selection for your climate, planting, pruning, pest management, harvesting and storing, everything you need to know. From Powell's Books:
http://www.powells.com/biblio/126200-126400/0963452037.html
From Chelsea Green:
http://www.chelseagreen.com/DP/Otto/BYOrchardist.htm

"Fruits of Warm Climates" by Julia F. Morton, ISBN: 0-9610184-1-0
Julia F. Morton is Research Professor of



Biology and Director of the Morton Collectanea, University of Miami, a research and information center devoted to economic botany. Covers 124 species, with an extensive bibliography; the entry for each species is a minor essay, with detailed treatment under Description, Origin and Distribution, Varieties, Climate, Soil, Propagation, Culture, Keeping Quality, Pests and Diseases, Food Uses, Other Uses. The approach is global -- Uses, for instance, covers the practices of traditional peoples throughout the world, including medical uses. Ms Morton provides a real wealth of information from her long experience of the subject. With photographs. Full text online: http://www.hort.purdue.edu/newcrop/morton/index.html

"Neem: A Tree For Solving Global Problems" National Research Council, 1992, National Academy Press, ISBN 0309046866
The wonder tree , traditionally called "the village pharmacy" in its native India. Neem provides a powerful pesticide that appears completely nontoxic to humans, mammals, and beneficial insects. In hot dry areas that are otherwise barren it gives ample shade and firewood year round. It is easy to establish and maintain. In India it is used to clean gums and teeth and is known to relieve a host of different pains, fevers, infections and other complaints -- it even has contraceptive properties. Yet neem remains relatively unknown and little utilized. From Fertile Ground Books:
http://www.agaccess.com/cgi-bin/webc.cgi/~fg/st_prod.html?p_prodid=BOS043&sid=22zsBD9
Read it online (free) at the National Academy Press:
http://www.nap.edu/books/0309046866/html/
More about neem:
http://www.theoriginalneemcompany.com/

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Poultry for small farms

Farming with animals

Mixed farming is best. Nature never tries to raise crops without animals, and the more species in attendance the better. This doesn't mean extra management problems, it means increased biodiversity -- which works in your favour in many ways, meaning fewer management problems. Fewer pests, less disease, higher yields, fertile soil, a healthy farm, and all your eggs in many different baskets.

Dexter cattle -- see below

Chickens are not just egg machines, they can do much more for you than that, if you let them, and reward you with better and cheaper eggs, more chickens, less work and a healthier farm.

Pigs are more than meat factories -- if you understand the nature and function of a pig's snout, you won't keep pigs inside on nice clean cement and face high feed bills, higher vet bills, and even higher mortality rates.

When you apply a variety of livestock to the land according to their nature, along with the crops according to *their* nature, in an integrated pattern according to Nature's nature, then all is well.

Even in a backyard with no fields, no forage, no pasture, and no orchard, the same rules apply -- it's always possible to follow Nature's rules.

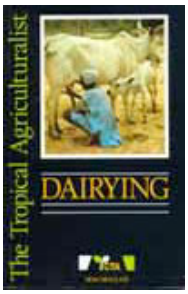
You really have no room for livestock? Not even a rabbit? Well, there's always *you*, and the way you apply yourself to the land. (See, for instance, **Humanure**.)

See also:
Pasture
Pigs for small farms
Poultry for small farms

Livestock resources

Cattle

"The Family Cow" by Dirk Van Loon, 1983, Storey Books, ISBN 0882660667
The complete reference for the family that decides to keep a cow. Selection, handling, grooming, housing, fencing, grazing, feeding, milking, breeding, calving, calf health and more. Well illustrated and based on direct experience. Basic, yet dealt with in depth, and entertaining. What about slaughtering? Well, decide for yourself. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/FamilyCow.html



"Dairying" by Richard Matthewmann, 1993, Tropical Agriculturalist
The sixth in The Tropical Agriculturalist series of livestock books. Covers in detail the rearing, husbandry and management, feeding and nutrition of calf, heifer and milk cows. Describes many examples of milk production systems, development issues, constraints on tropical farmers. Milk breeds, cattle breeding, milk processing, products and marketing. From ECHO's Global Bookstore:
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There's a worldwide surge of interest in **Dexters**. These tiny cattle stand not much more than 3ft at the shoulder and look like toys, but in fact they're tough and hardy, and very useful -- they're just about perfect for smallholders. They need less pasture and feed, but they produce more milk for their weight than any other breed, with average yield of about 1.5-2.5 gallons a day and up to a quart of cream per gallon. They're dual-purpose cattle, raised for both milk and meat: high-quality

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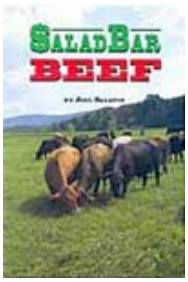
Why it really matters

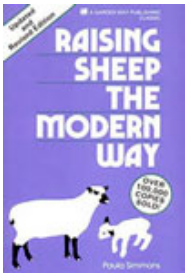
choice-grade lean meat with little waste. The cows are highly fertile and drop their calves in the field without difficulty. They thrive in hot as well as cold climates and do well outdoors year round. And they're gentle-natured beasts and easy to handle. Originally bred by smallholders in southern Ireland and left to roam in the mountains almost wild.
http://www.ansi.okstate.edu/BREEDS/cattle/DEXTER/index.htm
American Dexter Cattle Association
http://www.dextercattle.org/



"Salad Bar Beef" by Joel Salatin, 1995
"Salad bar beef receives no grain -- ever. God made multi-stomached animals to eat forages." Quite right too. Salatin's salad bar beef program is a proven, profitable prototype for small herds, yielding a high-quality, competitively priced, high profit-margin product. No more feed lots! This how-to book explains the why, how, and who of small-scale, organic livestock management. From Chelsea Green:
http://www.chelseagreen.com/DP/Polyface/SaladBarBeef.htm

"The Small Dairy Resource Book: Information Sources for Farmstead Producers and Processors", Sustainable Agriculture Network -- 56-page annotated bibliography of books, periodicals, videos and other materials on farmstead dairy processing, each with a concise review, for farmers and others interested in adding value to dairy products. Covers on-farm cheesemaking, ice cream, butter, dairy processing, raising dairy animals, business & marketing, food safety, and feeds & grazing. Out of print -- free Acrobat pdf version (990 kb):
http://www.sare.org/publications/dairyresource/dairyresource.pdf

Sheep



"Raising Sheep the Modern Way" by Paula Simmons, 1989, Storey Books, ISBN 0882665294
The small-scale sheep raiser's bible, revised and updated with fresh information, and a new chapter on using sheep dogs. A book that spends more time in the barn than on the bookshelf. Comprehensive, care and feeding, lambing, shearing, orphans, making a profit. From ECHO's Global Bookstore:
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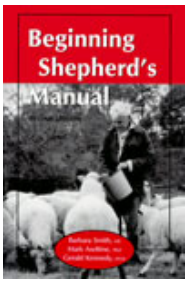

"Beginning Shepherd's Manual" by Barbara Smith, 2nd edition 1997, Iowa State University Press, ISBN 081382799X
Clear and practical introduction to shepherding, small or large flocks. Updated with new chapters by two new contributors: "On Location" features people who are active shepherds. From Powell's Books:
http://www.powells.com/biblio/102400-102600/081382799X.html
From Sheep Magazine Books:
http://www.sheepmagazine.com/books.html

"Sheep Raiser's Manual" by William Kruesi, 1985, Williamson, ISBN 0913589101
Sheep are useful for family farms. They help convert crop residues into a profit, or they follow cattle in a grazing scheme to production, or they graze steep pastureland. This book fills the gap between good beginners' books and manuals for commercial producers. Aims to help you turn a profit. Good on management, good section on breed selection, useful reference. Clear and concise diagrams. From ECHO's Global Bookstore:
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Sheep are important in tropical countries -- in fact there are more sheep in developing countries than in the developed world. Ordinary woolly sheep can thrive in warm climates, but hair sheep are better adapted to the tropics -- no wool, but plenty of meat. Sheep can thrive in dry and infertile areas where other livestock and crops would die. In arid regions they are a lifeline. Tropical smallholders are increasingly using sheep to control weeds in orchards, and in rubber tree and coconut plantations, saving money and increasing production, while the sheep manure helps to fertilise the trees.

"Sheep" by Ruth Gatenby, Tropical Agriculture Series, 1991, ISBN: 0333523105
Covers sheep production in Africa, Asia and Latin America. Easy-to-read guide on the characteristics and requirements of sheep, how to raise and produce them in a variety of tropical zones, breeding, health, nutrition and processing and production of meat, wool, skins, and milk. From ECHO's Global Bookstore:
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"Manual of Sheep Production in the Humid Tropics of Africa" by J. Charray, J.M. Humbert and J. Levif, translated by A.A. Leeson, 1992, CAB International, ISBN 0851987958
From CABI Publishing:
http://www.cabi.org/Bookshop/book_detail.asp?isbn=0851987958

"Understanding Sheep Production" by Claudia S. Ingham, Understanding Technology Series, Technical Paper # 71, Volunteers in Technical Assistance (VITA), 1990 -- Usual thorough overview from VITA, main focus on small-scale production in the Third World.
http://www.vita.org/publications/technology.htm

sheep! magazine -- "The publication for practical sheep farmers..." Subscriptions, Current Events, Profitable Sheep Tips, Current Issue, extensive sheep links and resources
http://www.sheepmagazine.com/

Dairysheep email mailing list, for those interested in dairy sheep and sheep dairying.
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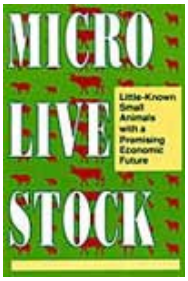
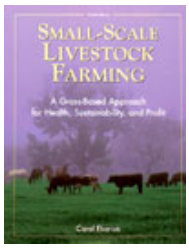
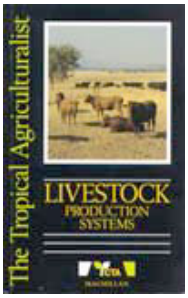
General



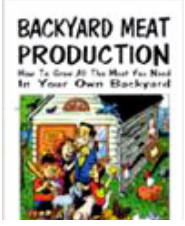
"Microlivestock: Little-Known Small Animals with a Promising Economic Future", 1991, Board on Science and Technology
Small animals require less feed and space and are easier to care for. This fascinating report makes suggestions for replacements for conventional livestock. Covers the microbreeds of cattle, goats, sheep, pigs, many breeds of poultry, rodents, deer, rabbits, lizards, and others, with appearance, distribution, habitat, biology, behaviour, care, pros and cons, and research needs. Read it online (free) or print it out at the National Academy Press:
http://www.nap.edu/books/030904295X/html/



"Small-Scale Livestock Farming: A Grass-Based Approach for Health, Sustainability, and Profit" by Carol Ekarius, 1999, Storey Books, ISBN 1580171621
Natural, organic approach to livestock management that produces healthier animals, reduces feed and health-care costs, and increases profits. Basics of animal housing, fencing, health, reproduction, and feeding. In four sections: overview, animal husbandry, marketing (conventional and alternative), planning. With interviews and information from other farmers and ranchers all over the US. From Lehman's Non-electric Catalog:
http://www.lehmans.com/cgi-bin/ncommerce3/ProductDisplay?prmenbr=12426&prrfnbr=14485&FROM_CAT_REF=12822
From Storey Books:
http://www.storeybooks.com/new_sell_sheets/162-1.html

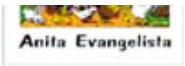


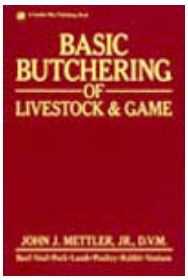
"Livestock Production Systems" by R. Trevor Wilson, 1995, Tropical Agriculturalist
Examines how different species of domestic livestock can be integrated into sustainable agriculture in the tropics. All types of livestock are covered including buffalo, camels, poultry, rabbits, guinea pigs, even snails. Wide range of case studies from tropical countries with practical models for livestock husbandry. Shows how livestock are essential for the development of ecologically sound systems of food production, and how livestock and crop husbandry can be linked in the humid tropics to improve the use of resources. The 10th in Tropical Agriculturalist series of 15 books on animal production in the tropics (others on poultry, sheep, pigs, rabbits, ruminant nutrition, dairying, animal breeding, animal health, goats). From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/



"Backyard Meat Production: How to Grow All the Meat You Need in Your Own Backyard" by Anita Evangelista, 1997, Breakout Productions, ISBN 1559501685
You needn't live in the country -- most urban areas allow for small-animal husbandry at home. Instructions to help you meet the family's animal-protein needs for a fraction of your current costs, and do-it-yourself feeding and butchering means healthier meat -- no food additives, no sloppy processing, no lethal diseases. Covers rabbits, chickens, quail, pheasants, guineas, ducks, mini pigs, mini goats, plus leather, feathers, bones, and fibre, butchering, with a

resources list.
http://www.rodaleinstitutestore.org/store/customer/product.php?productid=1009&cat=399&page=1





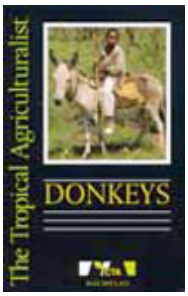
"Basic Butchering of Livestock and Game" by John J. Mettler, Jr., DVM, 1986
This is the book for anyone who hunts, farms, or buys large quantities of meat. Takes the mystery out of slaughtering and butchering everything from beef and veal, to venison, pork, lamb, poultry, rabbits and small game. Also processing and preserving. Clear and easy-to-follow, with 130 detailed illustrations, complete, step-by-step instructions. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/

Draft animals

Rural Heritage -- bimonthly journal since 1976 in support of small farmers and loggers who use draft horse, mule, and oxen power. Where horsepower means horses -- great resource for everything about animal traction, loads of information and resources, even a virtual vet. Tractors are all very well, but they use fuel -- you can grow your own (see **Biofuels**), but there's still a problem: no manure.
http://www.ruralheritage.com/

"Modern Mule" by Paul & Betsy Hutchins
Breeds and types, hinnies, miniature mules, drafters, training, working, packing, riding, harnessing, driving, problems. Why mules? They last longer, they're healthier, less trouble, eat less, better workers, more intelligent than horses, and stronger than donkeys. See:
http://www.ruralheritage.com/mule_paddock/mule_why.htm
Order online from Rural Heritage:
http://www.ruralheritage.com/bookstore/catalog_details.cgi?recno=42

"Definitive Donkey" by Betsy & Paul Hutchins, ISBN 0-9659312-0-x
Selection, care, feeding, breeding, and training donkeys for driving, riding, packing, plus using singles and teams for light work. Includes Donkeys Around the World, Having Fun with Your Donkey. Donkeys aren't at all stupid, and they're not stubborn -- it's just that they prefer their own opinion to yours (which is intelligent). You can work it out between the pair of you. They make great guard animals -- a donkey will take care of a whole herd of cattle, sheep or goats. From Rural Heritage, order online:
http://www.ruralheritage.com/bookstore/catalog_details.cgi?recno=56



"Donkeys" by Denis Fielding & Patrick Krause, 1998, Tropical Agriculture Series
Valuable guide for anyone using or breeding donkeys. Promotes a better appreciation of the benefits of using the donkey in the tropics, as a draught animal, as a pack animal and for riding. Covers donkey physiology, nutrition and feeding, breeding, husbandry, and management, use of the donkey as a work animal with details of harnessing and equipment, health and disease, care of donkeys. Also the mule and hinney.
http://www.echotech.org/bookstore/

"The Design and Manufacture of Animal-Drawn Carts" by Ian Barwell and Gordon Hathway of I.T. Transport Ltd (UK), 1986, Intermediate Technology
Covers different types of carts and how to build them. Photographs and line drawings. Two-wheeled carts, four-wheeled carts, tippers, bottom-dumpers, water-carriers, bodies, axles, wheels, suspension, horses, oxen, camels, harnessing and hitching, lots of detail. Most people in developing countries don't have transport. Often they don't even have roads. But the planners ignore every option that doesn't have a motor. So people usually use their legs to travel, and transport goods on their backs. There are many local alternatives, but they get no support and are few and far between. This book is the first of a series by the ILO and UNCHS/HABITAT on low-cost vehicles. A few countries still have traditional cart-making skills, but most don't. Animal carts are cheap and efficient, they don't need much of a road, they're easy to build, and they're sustainable. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/

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Farming with animals
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Aquaculture for small farms
Composting for small farms
Controlling weeds and pests

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Farming with animals

Pasture for small farmers

Forest and meadows (Christine Thery)

A rye plant may have as much as 25 miles of roots. A rye grass plant may have as much as 350 miles of roots. This is the difference between grassland and other land: grassland topsoil is a dense web of roots.

Grassland is not just grass: there will also be legumes (such as clovers) and deep-rooting herbs ("weeds", also known as forbs). The legumes have nodules in their roots colonized by special soil bacteria (rhizobia) that "fix" nitrogen from the atmosphere into food for plants. The herbs bring up new minerals from the subsoil and replenish the topsoil.

The most important aspect of grassland is the grazing animals that eat the grass. Along with the grazing itself and their trampling effect, it is the action of the animals' dung and urine in fertilizing the topsoil that makes such lush growth and crop density possible.

Pasture and grazers can almost be viewed as a composite creature, the one an aspect of the other. In a sense the grazers *cause* the pasture: remove the animals and the land changes.

First the annual "weeds" take over, followed by briars and shrubs, then young trees. After a few years there are mainly trees, and eventually a closed-canopy forest. This is called a natural succession.

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Not understanding the process of natural succession is why people try to fight weeds instead of manipulating soil, crops, trees and livestock in genetically diverse patterns which accomplish what the weeds are trying to accomplish.

You see grassland but no grazing animals? Look closer: one of the main grazing animals of Europe and North America, if not the main one, is not cattle or sheep, but the tiny vole (field mouse), with its myriad runs under the surface of the grass. Voles and rabbits can maintain grassland all by themselves. And both wreck trees.

On a farm, pasture has two main functions: it's immensely productive, and it can be used to provide enough fertility for a following succession of crops. This is the foundation of mixed-farming rotations, a productive and sustainable system.

Pastures can be grazed or mown for hay, storing the grass for later feeding. See Haying FAQ, below. If you can find someone who knows how, learn how to dry hay on tripods, and you'll have the best hay going, the animals choose it every time. Silage is another method of conserving hay, through fermentation, a bit like making sauerkraut.

See also:
Poultry for small farms
Pigs for small farms, Pigs on pasture
Farming with animals

Pasture resources

"Ley Farming" by Sir R. George Stapledon and William Davies, 1948, Faber & Faber, London.
Sow a piece of land with a good pasture mixture and then divide it in two with a fence. Graze one half heavily and repeatedly with cattle, mow the other half as necessary and leave the mowings there in place to decay back into the soil. On the grazed half, you've removed the crop (several times) and taken away a large yield of milk and beef. On the other half you've removed nothing. Plough up both halves and plant a grain crop, or any crop. Which half has the bigger and better yield? The grazed half, by far. "Ley Farming" explains why "grass is the most

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important crop" and how to manage grass leys. Leys are temporary pastures in a rotation, and provide more than enough fertility for the succeeding crops: working together, grass and grazing animals turn the land into a huge living compost pile. Stapledon draws on the work of Captain Elliot of Clifton Park, whose work with deep-rooting leys was the culmination of hundreds of years of development in grass rotation farming. Other books by Stapledon: "The Land: Now and Tomorrow", "The Way of the Land", "The Plough-up Policy and Ley Farming". .

"The Clifton Park System of Farming, and laying down land to grass -- a guide to landlords, tenants and land legislators" by Robert H. Elliot, introduction by Sir R. George Stapledon, 1898, 1943, Faber and Faber
The master-work of the ley farming rotational grazing system of laying down cropland to grass -- actually a complex mixture of grasses, legumes and deep-rooting herbs (aka weeds). The grass ley provided beef and dairy produce, as well as enough high-grade soil fertility for a succession of grain and root crops after the grass was ploughed up.
http://www.soilandhealth.org/

Good set of four FAQs from 18 James, home site for rural FAQs for small producers, useful information. Detailed advice -- the **Pasture FAQ** is more than 16,000 words, well-written and knowledgeable.
Pasture FAQ, establishing, maintaining, and utilizing livestock pastures;
Haying FAQ, growing, harvesting, and storing hay;
Lambing FAQ, lambing, and the care of ewes and lambs;
Predator FAQ, identifying and thwarting livestock predators.
http://www.18james.com

"The Economy of Low-Cost Homestead Haymaking: The Whole Story" by Spyridon (Rick) Grossman. There is no reason that anyone with access to a meadow or unused pasture cannot make their own hay. The tools are very simple. Something to mow with, a rake, a fork to handle the hay, a wagon to haul it, and a place to store it. Weather is more important than the type of tools. Here's how.
http://www.hooiberg.info/divers/denkna.htm

"Salad Bar Beef" by Joel Salatin, 1995
"Salad bar beef receives no grain -- ever. God made multi-stomached animals to eat forages."

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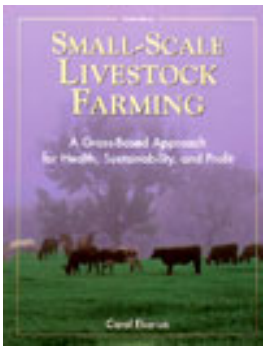
Quite right too. Salatin's salad bar beef program is a proven, profitable prototype for small herds, yielding a high-quality, competitively priced, high profit-margin product. No more feed lots! This how-to book explains the why, how, and who of small-scale, organic livestock management. From Chelsea Green:
http://www.chelseagreen.com/2004/items/516



"Small-Scale Livestock Farming: A Grass-Based Approach for Health, Sustainability, and Profit" by Carol Ekarius, 1999, Storey Books, ISBN 1580171621
Natural, organic approach to livestock management that produces healthier animals, reduces feed and health-care costs, and increases profits. Basics of animal housing, fencing, health, reproduction, and feeding. In four sections: overview, animal husbandry, marketing (conventional and alternative), planning. With interviews and information from other farmers and ranchers all over the US. From Lehman's Non-electric Catalog:
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From Storey Books:
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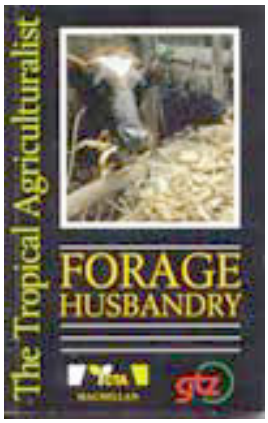
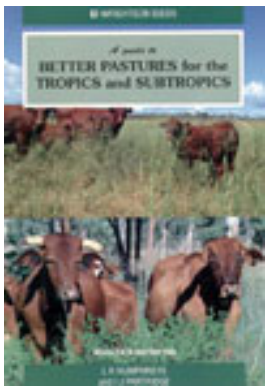


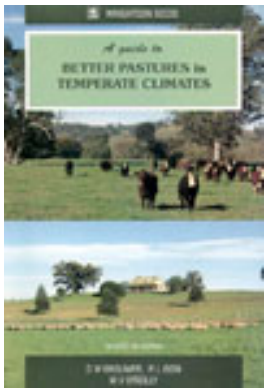
"Forage Husbandry" by Wolfgang Bayer & Ann Waters-Bayer, 1998, Tropical Agriculturalist
Covers the principles of forage husbandry and the functions of different types of forage and their integration with farming systems. Deals with forages for small-scale farmers and pastoralists husbanding available resources to sustain their livestock through the seasons, from deserts to humid grasslands, low to high altitudes, from nomadic pastoralism to intensive stall-feeding. With case studies. Lists important species of forages. The authors have considerable experience in forage husbandry and farming systems research and development in a number of countries in the tropics and subtropics. Other books in the series deal with individual animal species -- sheep, goats, dairy cattle, donkeys and camels -- and with ruminant nutrition

and livestock farming systems. From ECHO's Global Bookstore: http://www.echotech.org/bookstore/



"A Guide to Better Pastures for the Tropics and Subtropics" by L.R. Humphreys and I.J. Partridge, NSW Agriculture, revised 5th edition 1995, ISBN 1 86277
Good resource for tropical pasture development. Why sow pastures? -- establishing pastures -- fertilizing pastures -- managing pastures -- selecting pasture mixtures -- pasture grasses -- pasture legumes -- pasture species for irrigation or high altitude country -- fodder crops -- sowing guide. Four chapters online: Grasses for the tropics, Legumes for the tropics, Grasses for the subtropics, Legumes for the subtropics -- with fact-sheets for each species.
http://www.dpi.qld.gov.au/pastures/4605.html
Order the complete book from the CB Alexander Agricultural College, NSW Agriculture:
http://www.agric.nsw.gov.au/Agedu/Tocal/wstrop.htm

Useful list of books on tropical pastures at the **Tropical Grassland Society of Australia**, order form online:
http://www.tropicalgrasslands.asn.au/



"A Guide to Better Pastures in Temperate Climates", by D.W. Brouwer, R.L. Ison, M.V. O'Reilly, NSW Agriculture, 1994, ISBN 0 9594313 3 0
Pasture improvement, the place of legumes in soil, pasture and crop improvement, fertilizers, pasture establishment and maintenance, selecting species, cultivars and mixtures, pasture grasses, pasture legumes, pasture management, fodder conservation and fodder crops, seed quality, reference charts and sowing guide. From the CB Alexander Agricultural College, NSW Agriculture:
http://www.agric.nsw.gov.au/Agedu/Tocal/wstemp.htm

The **Forage Information System** is a big site with extensive resources on virtually all aspects of the subject. The Animals page, for instance, has information on Breeds, Farms/Ranches, General Info, Markets, Nutrition, Prices, Organizations, and Publications/Other Media for Beef, Bison, Buffalo, Dairy,

Deer/Elk, Goat, Horse, Llama, Mule, Poultry, Rhatite, Sheep, Swine, and General Information. Also Cover Crops, Economics, Hay, Pasture, Pests, Quality & Testing, Silage, Species, Statistics. Separate Resources section offers links for Forage Information Systems, International links, Media, People, Publications, and Vendors. Publications can be sorted and browsed by Type (Books, Journals, Newsletters...) or by Subject Matter (Silage, Pasture, Hay...), or search the Publications database.
http://forages.orst.edu/

Pasture Management at The Small Farm Resource. Useful FAQ on managing pasture, lots more resources here on grass types, erosion control, manure management, silage, weeds, fences, sheep, goats, even ostriches. Try the site search engine.
http://www.farminfo.org/property/pastmgmt-m.htm
Forage for cattle:
http://www.farminfo.org/dairy/forage-m.htm
Forage Crops:
http://www.farminfo.org/forage/default.htm

"The Stockman Grass Farmer -- The Grazier's Edge" -- A publication devoted entirely to the art and science of turning grass into beef, lamb or milk -- ie, cash flow. Serves as an information network for grassland farmers sharing the latest in intensive grazing technology and pasture management. Subscriptions, bookshelf, audio tapes.
http://www.stockmangrassfarmer.com/

"Why Grassfed is Best!", a new book by New York Times bestselling author Jo Robinson, explores the many benefits of grassfed meat, eggs, and dairy products. This is the website for the book, with much of interest on the nutritional benefits of grass, environmental benefits, new research.
http://eatwild.com/index.html

A Campaign for Real Milk -- "What's needed today is a return to humane, non-toxic, pasture-based dairying and small-scale traditional processing." Also in French and German.
http://www.realmilk.com/why.html
A project of theWeston A. Price Foundation:
http://www.WestonAPrice.org

Back40Books -- Free-range poultry is a sustainable and profitable system. It was the norm in the US until it was superceded by industrial agriculture and confinement systems in

the 1960s. Herman Beck-Chenoweth has updated and modernized the old techniques in his "Modern American Free-Range System" -- this really is free range, not just a mobile confinement system with grass underneath. Resources and links, along with the Back40Books online book catalog, featuring books on poultry, other livestock, farming, country skills, and much besides.
http://www.free-rangepoultry.com/

"Free-Range Poultry Production and Marketing Range Poultry Production: A Complete Guide to Raising, Processing and Marketing Free-Range Chicken, Turkey and Eggs" by Herman Beck-Chenoweth.
The free-range system can produce healthier birds in larger quantities, more humanely, with much less labor. Complete with feed formulas, equipment plans, slaughter tips and marketing suggestions this is the one book you need to raise up to 20,000 birds per year with much less work than you thought was possible. Meat and egg chickens and turkeys. The book was produced with the assistance of the USDA Department of Sustainable Agriculture and Development (SARE). Companion video also available. From Back40Books:
http://www.back40books.com/store/prodinfo.asp?number=0-918779-00-6&variation=&aitem=4&mitem=17

"Range Poultry Forum Magazine: The Journal of Producing, Processing and Marketing Premium Quality Chicken, Turkey and Eggs" -- valuable information for ANY grass-based poultry producer regardless of system. Regular features on producers, hatchery profiles, direct marketing, predators, processing and more. Irregularly published; subscription is for four issues. Back issues available.
https://raju.safe-order.net/free-rangepoultry/p53.html

"Forages", by Dr. Franklin W. Martin, 1993, ECHO Technical Note. Forages on the small farm -- tropical focus. Management, recommended forages, grasses, legumes, other forage plants, tables and plant descriptions, seed and other resources.
http://www.echotech.org/

"Better Pastures for the Tropics", Yates, 1975 (Yates Agricultural Seeds, P.O. Box 117, Rockhampton, Queensland, 4700, Australia -- useful booklet on the seed company's work

developing tropical pastures.

Silage

Silage at Indore, India: "A special feature of the food supply of the oxen was the provision of ample silage for the months March to June, when little or no grazing was available on account of the dry, hot weather. The silage was made from the locally grown tall millet, cut up by means of a portable chaff cutter driven by a 5 h.p. portable oil engine. The cut silage was filled into pits about four feet deep with sloping sides and an earthen bottom for drainage. To prevent the infiltration of air into the mass from the surrounding earth the sides were leeped with a thick, moist, clay slurry just before filling. The cut silage was moistened by means of a sprinkler as it went into the pits, each of which was so designed that it could be filled with moist silage and covered in during one day's work. This is essential for the best results. It never pays to fill a silo bit by bit, as is so often the case in Great Britain. The centre of each filled silage pit was about eighteen inches above the ground level, the edges were flush with the undisturbed soil, a thin covering of dried grass was then applied, followed by a foot of earth. On the top of this earth covering were laid some heavy blocks of stone. All this consolidated the moist silage and allowed the proper fermentation to begin. No additions such as molasses were ever used. Proceeding in this manner, excellent silage was obtained with practically no loss. Indeed, damage by percolating air was impossible, while the small amount of liquid produced was absorbed by the earth below." -- *Sir Albert Howard, "Farming and Gardening for Health or Disease (The Soil and Health)", Chapter 9, Disease and Health in Livestock (Faber & Faber, London, 1945, Devin-Adair 1947, Schocken 1972).* Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

"Barn Plans & Outbuildings", Byron D. Halsted, Orange Judd Co, 1881, 1889 edition reprint 1999, Algrove Publishing, ISBN 0-921335-64-4
This great book on 19th-century American farm buildings includes a very good 10-page section on making silage: The Preservation of Fodder in Silos, with lots of detail and good engravings and diagrams. From Lee Valley Tools:
http://www.leevalley.com/

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Farming with animals

Pigs for small farms

Why pigs have snouts

-- "Pigs are ideal ploughs, rooting up weeds and turning over the ground, while they manure it at the same time. They need to have a house and temporary fence (eg, electric netting) to confine them to the area.

As soon as it has been cleared, move the house and fence ready for the next section." -- *Katie Thear, Country Smallholding Magazine*

Free-range pigs (Christine Thery)

-- "Use your own pigs, or borrow a neighbour's, to dig beds for you and to manure your land. Keep them in a moveable pen. Put them where you want your beds to be made. Leave them there until they have dug and manured enough. This is called a 'pig tractor'." -- *People's Farming Workbook*

-- "Pigs would make an excellent addition to a farm for pasture renovation. Pigs can be extremely rough on pasture. Why not use unrung pigs on poor pasture instead of a plow? Then just level and reseed. Fertility would be taken care of by rotational grazed pigs." -- *Greg Gunthorp, pasture pork producer*.

Raising pigs on soil in Japan

-- From "Multi-pollution" by Sawako Ariyoshi (first published in serial form in Asahi Shimbun newspaper from October 1974 to June 1975), translated by Midori Hiraga

I've heard many organic farmers saying: "I'm doing organic farming without hoping to make a profit." Some complain: "The biggest dissatisfaction is that consumers always demand cheap products. They don't think of the farmers who grow their food." But I finally found one young farmer who stated clearly: "I decided on organic farming because I want to make money." He was a 27-year-old pig farmer.

"You have to raise healthy pigs to make money," he said. "You can't raise healthy pigs on the artificial feeds on the market, and vets just inject

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lots of medicine when the pigs get sick. I don't want to eat such a pig -- and pigs don't become healthy with the medicines either. There are thousands of anti-fungicides and antibiotics in artificial pig feed. I can't let my pigs eat such stuff! The best food for healthy pigs is healthy soil."

The Ministry of Agriculture and Forestry in Japan says 65% of pigs sent to abattoirs are sick. The Department of Agriculture in the US reported that only half the piglets survive. Vets and scientists have concentrated on eradicating disease with new treatments, vaccinations, new antibiotics, but still, half the piglets die. So medicine couldn't solve the basic problem, and half the piglets die in protest.

A farmer in England reported: "If you confine pigs inside, many piglets will get diarrhoea [white scour]. I feed these sick piglets plenty of fresh soil full of humus, which contains no chemical fertilizers. I've proved that piglets stay healthy when they eat soil. You should start feeding piglets healthy soil when they're one week old, and continue until they're six weeks old. You'll be surprised how much soil piglets eat! The interesting thing is that it's no use at all feeding them chemically fertilised soil." [From "The Living Soil" by Lady Eve B. Balfour, Faber & Faber, London, 1943 -- see below.]

It seems the young farmer I met had done his homework. I had heard that soil is good for pigs, but I'd never actually seen such a pig. So I decided to visit him at his farm in the mountains.

He and his wife built their farmhouse themselves, using old wood thrown away a few years previously when it was a trend to build a new house. The couple met when he was 24, but their parents opposed the marriage, so they left their families and built their first house by themselves. An architect friend helped them with the structure, and they learnt basic construction techniques from him. Later they built pig housing on their own. His wife can even do welding.

The road to the house was untarred, red mountain soil, but there was plenty of rich black soil in the field in front of the pig pens. The farmer chased the pigs out of the house onto the field.

"It was just a mountain area full of trees and grass here," he said. "We set up electric fences around the field, but you only need to turn it on a couple of times. Pigs are smart and learn quickly, they won't try to escape after that."

Several pigs began digging in the soil with their noses. "Oh, this field

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was ploughed by pigs?" I asked.

"Yes. It was full of trees and grass, so first they ate grass, then they ate the grass roots and tree roots, and the trees fell down by themselves. You can see the timber over there," the farmer told me. There were piles of timber outside the fence, to be used for fuel wood.

A pig started urinating in front of me. Such a noise it made! The soil turned dark shining black with the pig's urine. Meanwhile, it was eating and digging in the soil all the time.

"How long did it take to clear all the trees and grass?" I asked.
"Well, less than half a year, I suppose," he said.
"With such a small herd of pigs?"
"The pigs do their job until they become pregnant. When they are pregnant, they stay in the house," he said.
"How long?"
"Three to four months."
"How long has this place been ploughed by pigs altogether?"
"About one and a half years. It's ploughed too much already, so I'm thinking to move to the next field," he said.

I was impressed to see the rich black soil in the field. Pigs had cleared the trees and grass, eaten it all, and quickly turned poor red mountain soil into fertile black soil rich in microorganisms, and the microorganisms then became good food for pigs. Black soil is soft and warm, it easily absorbs the warmth of the sun.

I hadn't imagined pigs' snouts could do such a job better than tractors. "It's a 'bull-*ton*-zer'," I said ("ton" means pig). The farmer laughed at my silly joke. He told me that costs are low farming pigs this way, and the pigs grow happily and healthily with plenty of exercise and lots of sunshine. Sows give birth to about 10 piglets twice a year.

"If you feed them soil, there are no weak or deformed piglets. Everything is so economical. Of course, you can only use the mountain soil nowadays."

Only the mountain soils are safe for pigs, most other soil is now too polluted.

Lady Eve's pigs

In "The Living Soil" (Faber & Faber, London, 1943), one of the founders of the organic growing movement, Lady Eve Balfour, tells how she kept her piglets healthy on her farm at Haughley in Suffolk, England. Pigs bred in modern housing are very prone to white scour -- prolonged diarrhoea. The text-books say it's caused by iron deficiency and recommend iron supplements, or, as an alternative,

What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox
School gardens
School composting
Trees and forests
The Beach House fish pond
HOMeR
Eco-footprint
School and youth programs on the Web
Education resources on the Web
Children's poetry

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Japan

feeding the piglets pieces of turf.

"I have made many experiments in connection with the curing and prevention of this trouble. From the turf remedy I tried experiments with ordinary soil from arable fields. It was not long before I found that soil gathered from a field rich in humus, where no chemicals had been applied, was quite as effective as turf, curing the pigs within forty-eight hours. Whereas soil from exhausted land, or land treated with chemicals, had no effect in curing the disease. I also noticed that young pigs running in the open on good pasture, provided it was not too hard for them to rootle (as, for instance, in hard frost, or very prolonged drought), never suffered from this disorder. It is never a menace to my herd now under any conditions, even in long spells of severe winter weather, when the ground is covered with snow, and the pigs have to be entirely housed up. Under such conditions I no longer wait for the first sign of scour, but regularly collect the soil of fresh mole hills, newly thrown up above the snow, on land I know to be fertile. Collected daily, this soil is friable in the hardest frost, and is equally good in very wet weather, for it is never sticky. The pigs eat it voraciously in incredible quantities, starting when about a week old. I sometimes add a little chalk to it, which the pigs seem to like."

"The Living Soil and the Haughley Experiment" by Lady Eve B. Balfour, Faber & Faber, London, 1943
http://www.soilandhealth.org/

See also:
Pasture
Poultry for small farms
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Pigs on pasture

Pastured Pigs -- Greg Gunthorp of Indiana is a fourth-generation pasture pork producer. This is what he says about the confinement hog industry: "Every problem that buildings create could be cured by pasture. I know because I have a partially slatted building that sets empty because I can't afford the death loss in it!" And about vet bills: "Medication on pasture operations is a waste of good money. You can't lower an almost 0% death loss from weaning to market." And: "I don't vaccinate little pigs. I don't give them any shots. I don't clip teeth. I

A happy pig at the Gunthorp Farm

don't give iron shots. My death loss is non-existent." Three interesting how-to's on the Gunthorps' website: Pastured Pigs, Pasture Farrowing Hints, Pastured Hog Hints. Greg says it would take a 300-page book to cover the subject properly, but he welcomes inquiries.
http://grassfarmer.com/pigs/gunthorp.html

Pastured Pigs Discussion Group. Email mailing list for the exchange of ideas about raising pigs on pasture.
Post message: PasturedPigs@yahoogroups.com
Subscribe: PasturedPigs-subscribe@yahoogroups.com
Unsubscribe: PasturedPigs-unsubscribe@yahoogroups.com
Post message: PasturedPigs@yahoogroups.com
List url: http://groups.yahoo.com/group/PasturedPigs
Message archive, with search:
http://groups.yahoo.com/group/PasturedPigs/messages

Forages for Swine -- Some useful advice from the Agronomy and Animal Siences Departments at the University of Missouri-Columbia, recalling that pasture was formerly an absolute essential for a successful swine operation. "Use of good pasture containing alfalfa, ladino clover, and grass can lower sow feed costs, help maintain high level reproductive capacity of boars, and in many cases increase litter size as compared to confinement raising."
http://muextension.missouri.edu/xplor/agguides/ansci/g02360.htm

Hogs in the Garden: Joel Orcutt keeps his garden in better shape with less effort by using "hog tractors" as ploughs -- and raising pigs for the market at the same time. This is what pigs were made for, not to have rings in their noses. Clear, concise how-to.
http://www.ottermoon.com/articles.php?lng=en&pg=114&prt=1

"Understanding Swine Production" by Vernon M. Meyer, Douglas Henderson, Understanding Technology Series, Technical Paper # 39, Volunteers in Technical Assistance (VITA), 1985 -- Good overview of pork production, main focus on small-scale, comparing pasture with confinement systems. Understanding Technology Series
http://www.vita.org/publications/technology.htm

The **Kunekune** is a cute and friendly little pig from New Zealand, smaller than other pigs and with one other big difference -- they're grass eaters. A Kunekune is quite happy eating grass alone: you can use them as a lawnmower, and unlike other pigs, they won't harm trees or shrubs. If you don't have grass or an orchard to graze them in, household scraps will do. Great for smallholders or backyard farmers,

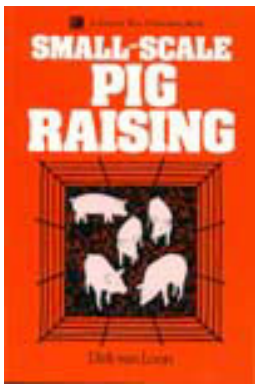
Kunekune (Katie Rigby)

high-quality meat. http://www.ansi.okstate.edu/breeds/swine/kunekune/index.htm

Pig Paradise Farm: Pig arks -- traditional outdoor living for pigs: cleaner, healthier, cheaper, more natural. http://www.pigparadise.co.uk/arks.html

Pigfeed from water hyacinth: "Boiled water hyacinth is used in Southeast Asia as a feed for pigs. The plants are chopped and sometimes mixed with other vegetable wastes, such as banana stems, and boiled slowly for a few hours until the ingredients turn into a paste, to which oil cake, rice bran and sometimes maize and salt are added. The cooked mixture is good for only three days, after which it turns sour. A common formula is 40 kg of water hyacinth, 15 kg of rice bran, 2.5 kg of fish meal and 5 kg of coconut meal." -- from "**Water hyacinth, million dollar weed**".

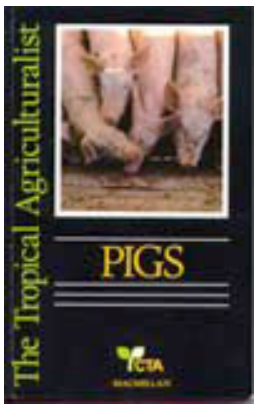
Pig resources



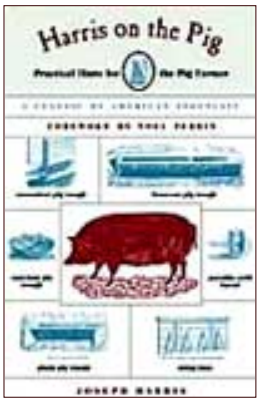
"Small-Scale Pig Raising" by Dirk van Loon, 1978
Explains why raising a feeder pig is the best bet for someone with little land who wants to produce the most meat for the smallest investment of time and money. Covers everything from buying a pig to smoking your own bacon. "In writing this book I have tried to create the kind of how-to and why guide I wish I'd had when we first raised pigs." For beginners, but goes further and deeper than most introductory books. History, swine management practises through the centuries, home butchering, with step-by-step instructions and many photos covering the entire process from slaughtering to portioning meat for the freezer. From Lehman's: http://www.lehmans.com/jump.jsp?itemType=PRODUCT&iProductID=2076

"Raising Pigs Successfully" by Kathy and

Bob Kellogg, 1985
Home pork production could be the easiest (and most delicious) way to put meat on your table for pennies a day. It's easy, inexpensive and fun. Covers everything the home hog raiser needs to know with plenty of innovative ideas. Choosing best breeds, piglets, housing and pens, daily care and maintenance, feeds, water, troubleshooting, basic breeding, slaughtering, freezing and packaging, includes biogas production from swine manure. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/

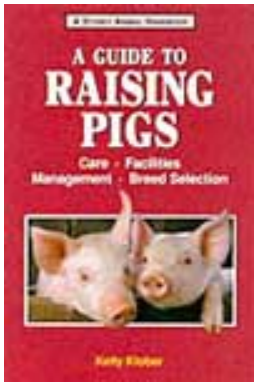


"Pigs" by David H. Holness, 1991, CTA/Macmillan
The nature of pigs, how to raise and produce them in a variety of tropical zones and farming systems, pig characteristics and requirements. A comprehensive, easy-to-read and well-illustrated guide, for both the commercial producer and the village pig-keeper, aims to transfer ideas not only from developed countries to the tropics but also between tropical countries. World pig population, Understanding the pig, Systems of production, Breeds and breed improvement, Principles of feeding and feed resources in the tropics, Housing, Health, Practical management, Processing and marketing. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/



"Harris on the Pig: Practical Hints for the Pig Farmer" by Joseph Harris, Noel Perrin, 1999, Lyons Press, ISBN 1558219781
One of the handy Farm Devices series of reprinted books from the turn of the century. These books give modern readers a peak into history, showing how previous generations did it. They are absolutely practical today for anyone looking for alternative ways of doing things or those trying to use appropriate technology. Includes a comprehensive introduction to various breeds of pigs, a common-sense approach to feeding, step-by-step instruction on building piggeries and pens, plus dozens of other useful lessons, all leavened with a healthy dose of humor. Gems of knowledge abound -- a veritable swine bible. Well-illustrated with original line art and engravings. From The Lyons Press:
http://lyonspress.com/gard_gen.asp
Shop Goody's General Store
http://www.goodysgeneralstore.com/books.html

Full text online at Cornell University's Core Historical Literature of Agriculture Library:
http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2914263



"Storey's Guide to Raising Pigs" by Kelly Klober, 1997, revised and updated, Storey Books, ISBN 1-58017-326-8
A practical and comprehensive guide for small-scale pig producers and those who want to keep a family pig. An easy to read text covering breeds, feeding, housing, health maintenance, disease prevention, breeding, butchering, fitting and showing, and pig raising as a business. From Storey Books:
http://www.storeybooks.com/new_sell_sheets/326-8.html

"Pig Husbandry in the Tropics", 1996, Agrodok Publications, Agromisa
This Agrodok series booklet by Agromisa, a Dutch non-profit group, is simple, practical and detailed. Pigs are found everywhere, often kept by peasants, but methods and function differ widely. For women (and children), pig keeping can be of great importance as an independent economic activity yielding cash which is used directly within the family. Describes three pig keeping systems in developing countries. Covers improvements in housing, reproduction and feeding methods and in preventing and treating diseases, with a blueprint for small-scale commercial pig keeping for developing countries, with variations according to local need. Also covers scavenging (untethered) pigs and tethered pigs, and uses of liquid manure and dung. From the Agromisa Foundation:
http://www.antenna.nl/~agromisa/agrodok/ad01.html

"Profitable Pork: Alternative Strategies for Hog Producers", 16-page bulletin from USDA's Sustainable Agriculture Network (SAN) -- Farmers producing pork on a small scale can preserve their independence in the face of the consolidating hog industry. The bulletin showcases alternative ways to raise pork profitably -- in deep-straw bedding, in hoop structures and on pasture -- producers have been able to save on fixed costs, find greater flexibility, identify unique marketing channels and enjoy a better quality of life. Profiles successful hog producers as well as the latest research on everything from greater profits to better-tasting

pork raised in alternative hog systems. Full text online: http://www.sare.org/publications/hogs.htm

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Farming with animals

Poultry for small farms

There's a lot of good poultry information on the Web, along with some excellent books for small-scale or backyard poultry keepers. (See **Poultry resources for small farmers**.) Here is some useful information you might not find so easily.

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Khaki Campbell ducks
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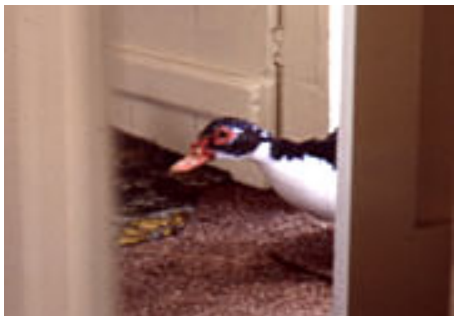
Muscovy ducks

First choice for small farms. "For really efficient meat production in the tropics we should be looking at Muscovy ducks," says ECHO (Educational Concerns for Hunger Organization). Not just in the tropics.

Keith passing the time of day with BD (Big Duck)

"We started with a drake and two ducks. After eight months we've had about 25 eggs to eat and 45 ducks of various sizes to eat." Mistake -- don't eat Muscovy eggs! Muscovies are for meat: they could've had 70 ducks. Duck eggs are great, but use Khaki Campbell ducks for eggs (see below), not Muscovies.



If you've never eaten Muscovy, you should know that it's really something. Muscovy is not at all greasy like other duck, it's more like extra-special veal, with a fine texture, no fat, and a unique and delicious flavour. It's the finest duck there is, and maybe one of the finest

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of all meats.

Muscovies are unique, the only domestic ducks that aren't derived from mallards. They come from South America and they're tree birds rather than water birds. So they don't need a pond to swim in. And they fly. They're much bigger and heavier than other ducks, and flying gives them large and powerful breast muscles, and strong, meaty legs.

Muscovy breast looks like a fair-sized steak, you wouldn't guess it was duck. It has a ready market and fetches a good price, and for the producer it's cheap and troublefree: Muscovies more or less produce themselves.

They're self-dependent, better foragers than other ducks, they grow fast and they seldom get sick. They clean up after your other livestock, eating what the others spill or leave.

Muscovy ducks are good mothers -- the little brown ones are Khaki Campbells hatched by the Muscovy (Keith Addison)

They're personable and intelligent, great to have around, and they're quiet: they don't quack, they hiss, and only when they have to -- they're not chatterers like geese, or showmen like roosters. Calm birds. And though they fly, they fly around, not away.

They come in black and white and various shades of grey, with a bright red crest around their eyes and above the beak, like a cockscomb, but they're all the same really. Muscovies have never been industrialized or "developed", probably because they don't come in standard sizes: the drakes are much bigger than the ducks. A full-grown drake weighs about 15 pounds, and a duck up to 9-10 pounds.

Start with a drake and three ducks. Muscovy hens can set three or four times a year, with clutches of eight to 21 eggs. The eggs hatch after 35 days, the birds are ready to eat 70 days later, or any time after that. The meat yield is higher than any other duck, with 50% more breast meat, which is 98% lean, and the skin has 50% less fat than other ducks.

It's said Muscovies are fat-free because they come from a hot climate and don't need the fat to keep warm. Strange, then, that in temperate winters they produce a

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warm waistcoat of fine down (a useful by-product). We've had Muscovies at temperatures dropping to -15 deg C, and they didn't mind at all. Hardy birds.

Muscovy Duck -- General information from the Poultry Breeds site at Oklahoma State University:
http://www.ansi.okstate.edu/poultry/ducks/muscovy/

Muscovy Ducks -- ECHO Technical Note, from the Poultry Research Centre, Papua New Guinea. Some good general advice, excepting that ducklings do not need to be removed from the mother -- Muscovy ducks are good mothers. Even ducklings without mothers can be left to roam together outside with fair safety (no dogs or cats though). They're sensible little beasts, like their mums. They don't need much feeding either -- all Muscovies are good at foraging and fending for themselves. Muscovies don't need nearly as much care and management as this article implies.
http://www.echotech.org/

Muscovy ducks -- Chapter 9 of **"Microlivestock: Little-Known Small Animals with a Promising Economic Future"**, 1991, Board on Science and Technology. Read it online (free) or print it out at the National Academy Press:
http://books.nap.edu/books/030904295X/html/125.html

Home Grown Cooking from HGTV -- Muscovy Duck with Burgundy and Cranberry Sauce, serves two:
http://www.hgtv.com/hgtv/ah_recipes_sauce_dressing/article/0,,HGTV_3194_1383740,00.html

Khaki Campbell ducks

Called Campbells because they were developed by Mrs Adele Campbell in Britain a hundred years ago, and they're khaki-colored, or darker, like cocoa, with green beaks, and the drakes have dark green heads and bronze backs and tails. Very cute ducks.

Adele mixed Indian Runner, Mallard, and Rouen ducks in search of an egg-laying machine, and succeeded admirably.

There are some breeds of chicken which might be able to outlay a Khaki Campbell, but they're probably highly specialized birds and more trouble than they're worth. Khaki Campbells are no trouble at all -- they're very hardy, and good foragers. They'll lay 300 eggs a year or more -- up to 340. And they'll eat all the slugs and snails in your garden, and clear the pond of mosquitoes. Good backyard duck.

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"Capable of sitting on and hatching its own eggs," says one reference -- no it's not! That's what Adele accomplished with them -- they don't get broody, and that's why they lay so many eggs. We only once saw a Khaki Campbell getting broody. She got agitated, quacked a lot, and fussed around in a thicket trying to make a nest, but after a few minutes she gave up and went for a swim instead, looking a bit puzzled and slightly embarrassed.

For more Khaki Campbells, put a few of the eggs under a nesting Muscovy. The Muscovy will hatch them, and look after the ducklings with her own. A chicken might do it too.

Indian Runners are also good egg-layers. Both types make good eating and meat production is good if you hatch the eggs under Muscovies.

You don't need a pond for ducks, but so much the better if you have one. Even a sunken bathtub will do, but make sure there's a shallow end so the ducklings can get out again, or they could drown. Don't let ducklings swim until they're a few days old.

Khaki Campbell Duck -- General information from the Poultry Breeds site at Oklahoma State University:
http://www.ansi.okstate.edu/poultry/ducks/khakicampbell/index.htm

Chickens

If you've only eaten industrial chickens up till now, then you really don't know what a chicken tastes like. A true free-range chicken from an organic smallholding or a backyard bird raised on scraps and scratchings is quite different -- you'll be amazed! And delighted.

Rooster at Peaceful Garden, Lantau (Keith Addison)

Chickens are a must on farms of any size, and the ideal bird where space is limited. They scratch -- once, twice -- sharp eyes spot little bugs and tiny weed seeds, the beak darts down. Try to arrange it so that chickens get to work over your whole place every season, along with the ducks.

Chickens give you meat and eggs, they'll mix, shred and manure your compost materials for you, they're not much trouble (more than ducks and geese though), and they put themselves away at night. You don't need a rooster to have eggs, but you do need one if you want to breed them. Chickens cluck away

busily and shriek if they're frightened.

Chickens at Peaceful Garden, Lantau

Roosters are noisy -- don't believe it that they only crow at dawn! But you get used to it.

Keep hens for laying, eat excess cockerels -- roosters fight, one is enough.

There are very many chicken breeds -- get what's most common in your area. Try for a good, all-round, general-purpose bird. Rhode Island Reds and Plymouth Rocks are general-purpose chickens. Leghorns are egg-layers, Cornish for meat. Bantams are conveniently small and good insect-catchers, and good setters too -- you can hatch other birds' eggs under a bantam.

Geese

Strict vegetarians, ace lawnmowers, excellent watchdogs, intelligent, very individualistic and opinionated, sociable, good conversationalists. Geese are great if you have the room: a fair-sized lawn or a small meadow, and a pond helps, but it's not essential. They're very little trouble, they can get most or all of their food from grazing and they help control weeds.

Feed them extra if you're breeding them. One goose egg's a meal for two. In their wild state, geese are one of the very few creatures that mate for life. Domestically they mate in pairs, so you need one female per male.

The first two eggs are infertile, take them away and cook them. You get more geese if you put the first lot of eggs under a broody Muscovy, then the goose will lay a second lot. Geese lay for 20 weeks in the year, from the spring.

Using Geese To Control Weeds -- Geese will not compact the soil as heavy machinery or people will. They will work seven days a week, rain or shine. They can be put into wet fields to work when machinery would bog down and cause severe damage to soil

structure. Their agile necks allow them to pull weeds close to and from within the crop plants, where machine or hoe cannot. At the end of the season the grower can also process the geese for meat and feathers. All of this is accomplished while the geese are naturally spreading nitrogen-rich manure all over the field. -- 3,000-word article, Metzer Farms, California.
http://www.metzerfarms.com/weeder.htm

Weeding With Geese, by Glenn Geiger and Harold Biellier, Department of Animal Sciences, University of Missouri-Columbia -- Why do geese eat certain plants with relish while showing no interest whatsoever for others? Perhaps only a goose knows the answer. Proper use of geese can practically eliminate the need to hoe and pull grass and weeds. Expensive hand labor is replaced. The University of Tennessee Agricultural Experiment Station reports that using geese in cotton fields can save $35 or more per acre. 1,600-word article.
http://muextension.missouri.edu/xplor/agguides/poultry/g08922.htm

Rabbits

Rabbits in a chicken tractor at Frogditch Farm, England (Keith Addison)

Rabbits breed like, well, like rabbits. They breed all year and the gestation period is only a month or less -- soon you'll have lots of rabbits. One buck to up to 10 does, but you have to keep them apart. You have to keep bucks apart too: rabbits fight. And they burrow under fences. Free-ranging is out, but chicken tractors work well. Good meat production but not trouble-free. If you have children they'll do the work for you -- children love rabbits. Grass, hay, vegetable scraps.

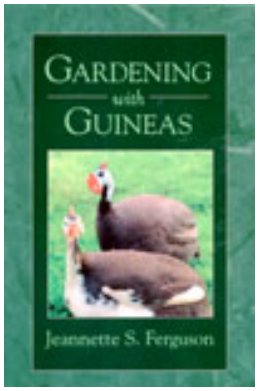
Start with a buck and two does and you'll have rabbit meat all year round. For breeding, take the doe to the buck, or they'll probably fight. Leave them together for two days, then take her back again 12 days later -- if she refuses to mate, then it worked the last time and she's pregnant. Leave her with her babies for six weeks, then mate her again two weeks later. In other words she'll breed four times a year.

Rabbit manure is high-quality, easy to handle.

Guineafowl

Guinea fowl are an all-round asset on a smallholding. The only downer is the weird and noisy noise they make -- and even that's an asset, because they're better watchdogs than watchdogs are (as good as geese). And you get used to the row. Guineafowl need very little care -- just leave them alone, they do what they like, feed themselves, look after themselves, and lay about the best eggs going. Smallish but rich and delicious! -- as they should be, nurtured on a rich and varied diet of insects and weed seeds. They effectively keep the pests down. Guinea fowl are THE best control for ticks.

Guinea Fowl for Tick Control -- "The second year we were here, we purchased a few guinea fowl. Ticks have been very rare in our life since then." Good basic tips on free-range guinea fowl.
http://www.countrysidemag.com/issues/3_1998.htm#Tick%20Control



"Gardening with Guineas -- A Step by Step Guide to Raising Guinea Fowl on a Small Scale" by Jeannette S. Ferguson, 1999, FFE MEDIA, ISBN 0739202502
Guide to raising guinea fowl, covers the life of a guinea from eggs to adults, including incubation, feeding, housing, training and common prolems. The only book of its kind. Order online from Jeannette Ferguson:
http://www.guineafowl.com/

General tips

Spreading wood ash on the floor of the chicken coop under the roosts is a good way of dealing with the droppings. The chicken manure and the wood ash react, driving off the nitrogen and drying out the manure, producing an easily handled, easy-to-store, organic fertilizer rich in potassium and phosphorus. (Like all "fertilizers", you get the best effect by adding it to the compost pile rather than the soil.)

Spread the type of "browns" you use for composting in the chicken run -- dead leaves, spoiled hay, straw, sawdust, shredded newspaper and cardboard, wood chips. Throw edible scraps from the vegetable garden and the kitchen on top. The chickens will scratch it up, manure it, and mix it thoroughly for you -- when it's ready, put it straight in the compost bin.

Vermicomposting -- with red worms -- makes extra sense if you have poultry. Worms are high protein (better than beef) and make excellent live (or dried) poultry feed. Worm populations double at least in six

weeks, and they eat their weight of compost material a day. It's not hard to figure it so that you get a good supply of excess worms for your poultry. See **Vermicomposting**.

See **"Friend Earthworm: Practical Application of a Lifetime Study of Habits of the Most Important Animal in the World"** by George Sheffield Oliver, 1941. Dr Oliver was one of the first to harness the earthworm to the needs of the farmer and gardener, making highly fertile topsoil for optimum crop growth, and producing a constant supply of cheap, high-grade, live protein to feed poultry. He devised simple yet elegant and effective systems to bring costs and labour down and productivity up to help struggling farmers make ends meet. Full text online at the Journey to Forever **Small Farms Library**.

High-protein poultry feed from thin air

Lots of flies around? Collect some kitchen slops -- cooking water and juices and leftovers from meat and fish dishes, some milk: anything that will go really putrid if you leave it for awhile. Then leave it for awhile. When it stinks really badly, gather some compost materials, say 4-5 cubic feet, spread it out in the sun, and sprinkle it with the putrid kitchen liquids. Don't get it too wet -- slightly more wet than compost should be.

In no time it'll be buzzing with flies. Leave it until you're quite sure lots of flies have had ample opportunity to lay their fill of eggs. Then scoop it all up, put it in a double garbage bag (one inside the other), put the bag in a suitably sized cardboard box, and close the bag lightly. It will soon stop smelling. Check it every day.

After a week or so, you'll open it to find the surface flat, finely divided, and writhing slightly, or even considerably, with maggots, lots and lots of maggots. Now's the time, don't leave them to turn into flies. Two options:

Option 1

Sift it with a circular gardener's sieve with a 3/16" mesh (stainless steel mesh is best). This will leave you with a pile of nice black compost and a sieve full of maggots -- first-class poultry feed. Your chickens, ducks, guinea fowl will think it's Christmas. The geese, who're strict vegetarians, will be appalled and disgusted by the whole thing, but never mind. Add the siftings to the compost bin or the worm bin. Maggots, by the way, assist rather than hinder the composting process. And, disgusting as they may look, fly maggots do not spread disease.

Option 2

Let the birds do the sifting for you -- but don't throw it onto their bedding or the mulch in their run because they'll miss a few maggots, leaving them to hatch into flies. On bare ground, they'll definitely get them all.

You've just wiped out a generation of flies.

Instead of using liquids, you can let a couple of litres of kitchen scraps get thoroughly putrid in a bucket with a lid on it and use that instead.

See **The Housefly** by Professor Roy Hartenstein, online at the Journey to Forever **Small Farms Library**.

Putting the Bluebottle Fly to Work -- from "Friend Earthworm: Practical Application of a Lifetime Study of Habits of the Most Important Animal in the World" by George Sheffield Oliver, 1941, online at the Journey to Forever **Small Farms Library**.

Poultry as unpaid labour

If you keep Muscovy ducks (you should!) there might not be enough flies around to make a boxful of maggots for you.

A Canadian study of fly controls with dairy calves found that Muscovies caught 30 times more houseflies than commercial flytraps, baits or flypaper. The ducks also ate spilled feed so flies couldn't breed in it.

The Heifer Project Exchange quotes a development worker in Togo in Africa reporting that the local people were not bothered by flies because their Muscovy ducks killed them all. They slaughtered some ducks, opened the crops to see what they'd eaten, and each one was filled with hundreds of flies. (ECHO)

Slugs and snails eating your salad greens? This is what Permaculture founder Bill Mollison said about it: "You don't have a snail problem, you have a duck deficiency." It's also old country lore: "There is no such thing as a surfeit of slugs, merely a dearth of ducks."

Particularly Khaki Campbell ducks, also Indian runners, though all ducks are ace slug catchers, they'll even go after their eggs in the soil. The ducks, though, might also appreciate your salad greens, so you'll have to watch them.

They're not pets

You can get very fond of these birds. Distinguish at an early stage between birds for breeding and birds for eating: you can give the breeders names, but DON'T name the meat birds, and don't let them charm you too much. Keep it in mind what fate you have in store for them!

Children can accept this as long as you're completely honest and forthright about it right from the start. Don't euphemize.

If you don't eat them they'll breed you out of house and home. If you can't stand the thought of killing them, then don't let them breed, just take all the eggs. Or get someone else to do it for you. You can learn slaughtering from a book, though it's better to get someone to show you.

Doing it

-- "Do you know how to kill a chicken?" Granny Choi asked. "Of course I do," Keith replied. "You take it by the head and chop its body off."

Decapitation is probably the best way, especially for beginners. Cutting their throats works well, and is probably just as instant. Reflex flapping makes both these ways messy. The non-messy way is to wring (break) their necks, but it takes practise to get it right and it's rough on the birds while you climb your learning curve. Maybe you know someone who can show you how.

Kill birds well away from the rest of the flock, take them away one at time -- don't make them wait in line for what they know is going to happen.

Head

Use a cleaver, the heavier the better, and keep it sharp. Use a big, heavy piece of timber as a chopping block. Hammer a nail into it near one end. Tie a short length of thin rope to the nail and put a noose in the other end. Lay the bird down on its back on the block, put the noose round its neck and tighten it -- not too tight. Hold the bird by the legs and pull it away from the nail so it can't move but isn't stretched. If you stroke its chest a bit and make gentle, reassuring noises it'll relax and probably close its eyes. Now's your chance. It needs a single, swift, well-aimed and decisive blow. Keep hold of the legs, hold the bird away from you until the reflex flapping stops.

Throat

Use a sharp knife with a longish blade (not serrated). Take the bird by

the feet and let it hang upside down for awhile. It will soon calm down and relax. Then hang it from a pole or rail about 6ft from the ground. Tie a thin rope to the rail and loop it a few times round the bird's feet. You can secure it with a short stick tied to the rope, tuck the stick between the legs. Take the head firmly but gently in one hand and cut across the throat about an inch below the head with a single, strong, sweeping cut. Step back and wait for it to stop flapping.

Plucking

Dip the carcase in hot water to loosen the feathers -- not too hot or you'll scald it and the skin will tear. If there's down, pluck the bird on a table and collect the down with a vacuum cleaner. Compost the feathers. Offal to the compost bin or the pig. Another option is to skin the bird, feathers and all.

See also:
Home Processing of Chickens -- Complete step-by-step instructions with photographs:
http://www.ianr.unl.edu/pubs/Foods/heg144.htm

See **Poultry resources**

See also:
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Farming with animals

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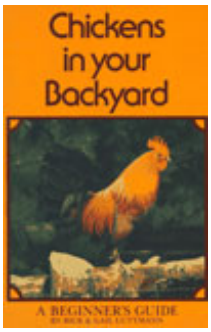

"Chickens in Your Backyard: A Beginner's Guide" by Rick and Gail Luttmann, 1976, Rodale, ISBN 0878571256
Perfect for beginners, steers you round all the traps. Presupposes no prior knowledge, step-by-step style, and it's written with wit. This was our first chicken book and we found we could rely on it -- though it's not quite as effective as one reviewer claimed: "It will have you laying eggs in days!" The chickens did, but not us! From Rodale Store: http://WWW.rodalestore.com/webapp/commerce/servlet/ProductDisplay?merchant_rn=15336&prrfnbr=13359
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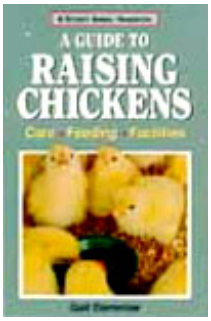
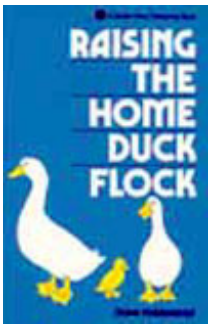


"Guide to Raising Chickens" by Gail Damerow, 1995
How to chose the right breed, care for chicks, feed the growing flock, build feeders and shelters, collect and store eggs, prevent health problems, raise broilers for meat. Everything from starting your own backyard flock to putting eggs on the table. Gail Damerow's been raising chickens for 25 years. She's the editor of Rural Heritage magazine and the author of eight books, including Chickens in Your Backyard and Ducks and Geese in Your Backyard. From ECHO's Global Bookstore: http://www.echotech.org/bookstore/



"Raising the Home Duck Flock" by Dave Holderreadd, 1978, 1983, Storey Books, ISBN 0882661698
The "Duck Owner's Bible", used by beginners and experienced duck producers alike. From eggs to ducklings to adults, health, feeding, butchering (with recipes), and using the feathers and down. Holderreadd has raised ducks all his life, owns a duck preservation centre dealing with rare breeds, and has taught duck raising and management. "Ducks are the easiest domestic birds to raise. They'll forage for much of their food, and they don't need to be pampered with expensive housing." Well-written, clear and thorough. From ECHO's Global Bookstore: http://www.echotech.org/bookstore/

"The Book of Geese -- A Complete Guide to Raising the Home Flock" by Dave Holderread, 1981, Hen House Publishing, ISBN 0931342023
Like his book on ducks, Dave Holderreadd's "goose bible" is used by beginning amateurs and professionals both. Well-illustrated, well-written book comprehensively covers the subject of these useful, quirky and likeable birds. From Powell's Books (use "Search"): http://www.powells.com/

"Profitable Poultry Production" by M. G. Kains, Orange Judd Company, 1910. "Poultry production is commonly practiced on every farm, but *profitable* poultry production so far as the farm is concerned, is rare indeed. No one, as a rule, has better natural conditions for poultry raising than has the farmer. It is only a matter of embracing opportunities that is wanting." Kains tells you how -- how-to's, plans, studies, and sound common-sense from long before confinement systems. The plans and drawings of coops and housing systems are a treasure in themselves. Kains was Poultry Editor of the American Agriculturist Weeklies, and author of the classic "Five acres and independence: a practical guide to the selection and management of the small farm", published in 1935 and still in print. Full text online at the **Small farms library**.

"Quail: An Egg & Meat Production System" by Dr. Franklin W. Martin, Alison G.

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Khaki Campbell ducks
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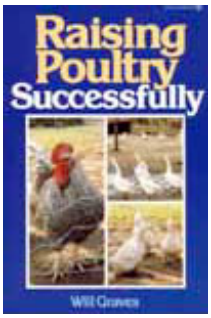
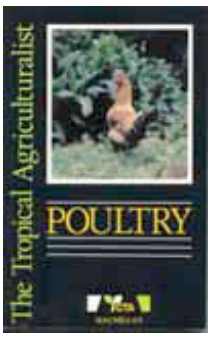
Healthcare for mountains
Seeds of the world
No seeds, no food

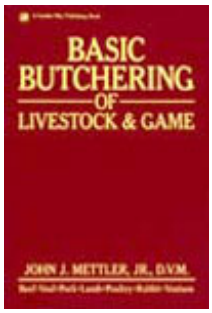
Martin-Davis & Annabelle Maffioli, ECHO Technical Note. "The eggs and meat production system explained in this publication is so small that it could fit into almost any home. It is a unique plan for use of a unique animal." The system produces about half a kilo of high-protein food per day at US$1 per kg -- or a fraction of that price if the family can produce its own high-quality feed.
http://www.echotech.org/



"Raising Poultry Successfully" by Will Graves, 1985, Williamson, ISBN 0913589098
Practical how-to book for small home flocks of chickens, ducks, geese. How to have high-quality meat and eggs cheaply and easily. Factual, clear, readable style. All the basics and more: Meat only, eggs only, or both? Home-grown or commercial feeds? Housing and watering, Butchering and dressing. With plans for portable and permanent chicken coops, publications, equipment sources. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/



"Poultry" by Anthony J. Smith, 1990, Tropical Agriculture Series
Detailed coverage of the characteristics and requirements of poultry, how to raise and produce poultry in a variety of tropical and sub-tropical zones and farming systems. Breeds and breeding, diseases and parasites, slaughtering and processing, marketing and profits. Deals with large-scale production down to village scavenging flocks. Comprehensive, easy-to-read. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/



"Basic Butchering of Livestock and Game" by John J. Mettler, Jr., DVM, 1986
This is the book for anyone who hunts, farms, or buys large quantities of meat. Takes the mystery out of slaughtering and butchering everything from beef and veal, to venison, pork, lamb, poultry, rabbits and small game. Also processing and preserving. Clear and easy-to-follow, with 130 detailed illustrations, complete, step-by-step instructions. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/

Raising Poultry -- Useful FAQ at The Small Farm Resource, good, practical stuff as usual on this site, emphasis on chickens.
http://www.farminfo.org/livestock/chickens.htm

THE COOP -- poultry resource on raising, breeding and showing poultry: chickens, ducks, geese, turkeys, wild waterfowl, gamebirds. Lots of user input. Good range of informative and useful articles at the Library, basics, background on breeds, how-to's, history, linked to categorized message boards. Directory of poultry people, breed clubs, new, used, rare and out of print poultry, pet and agriculture books at the Bookstore (online orders).
http://the-coop.org/index.html

The Poultry Connection is a large directory of poultry websites and resources, with forums, a bookstore and site search. Bantams, chickens and waterfowl, ducks and geese, peafowl and guineas, pheasant, quail, turkeys, chukar, pigeons and doves, emus, ostrich and rheas, rare breeds. Commercial production, diseases and disorders, farm sites, housing, incubation and brooding, equipment and supplies, nutrition and more.
http://www.poultryconnection.com/

The FeatherSite Poultry Page -- "This started out as a listing of the birds on my farm, but has evolved into an online poultry encyclopedia." An online zoo of domestic poultry, with photos, video and good information resources on chickens, ducks, geese, guinea fowl, pigeons, turkeys, even swans and peacocks, and non-domestic species. Broodiness and broody hens, coop plans (links), baby chicks, raising chicks, raising ducklings and goslings, incubation &

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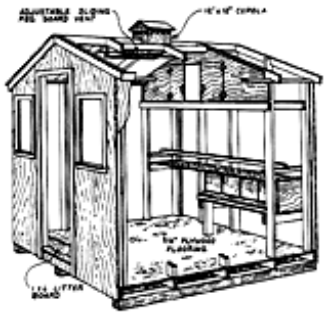
Japan

hatching, hatcheries, health, books on poultry, breed clubs, links, equipment, rare breeds, poultry glossary.
http://www.cyborganic.net/People/feathersite/Poultry/BRKPoultryPage.html

Poultry email mailing list for people seeking advice on poultry raising, husbandry or anything poultry related.
Post message: poultry@yahoogroups.com
Subscribe: poultry-subscribe@yahoogroups.com
Post message: poultry @yahoogroups.com
Unsubscribe: poultry-unsubscribe@yahoogroups.com
List url:
http://groups.yahoo.com/group/poultry
Message archive, with search:
http://groups.yahoo.com/group/poultry/messages



Small Chicken House -- Criteria for the "perfect" chicken coop, for 15-20 birds, with three diagrams and details.
http://www.piteraq.dk/gok/smallhouse.html

"Using Small Incubators" by Greg Davies -- useful tips on hatching eggs in your kitchen. Other articles on raising chicks, housing, and more at Greg's Chickens and Other Barnyard Birds site: Chickens, Pigeons, Waterfowl
http://www.i5ive.com/article.cfm/1889/21464

Make an incubator out of two cardboard boxes or plywood -- this is an online schools biology project but useful for smallholders or backyard chicken raisers. Uses commercial heating elements or light bulbs in porcelain sockets. Expect about a 50% success rate with 3 dozen eggs (commercial incubators: about 80%).
http://chickscope.beckman.uiuc.edu/resources/egg_to_chick/

Back40Books -- Free-range poultry is a sustainable and profitable system. It was the norm in the US until it was superceded by industrial agriculture and confinement systems in the 1960s. Herman Beck-Chenoweth has updated and modernized the old techniques in his "Modern American Free-Range System" -- this really is free range, not just a mobile confinement system with grass underneath. Resources and links, along with the Back40Books online book catalog, featuring books on poultry, other livestock, farming, country skills, and much besides.
http://www.free-rangepoultry.com/

"Free-Range Poultry Production and Marketing Range Poultry Production: A Complete Guide to Raising, Processing and Marketing Free-Range Chicken, Turkey and Eggs" by Herman Beck-Chenoweth.

The free-range system can produce healthier birds in larger quantities, more humanely, with much less labor. Complete with feed formulas, equipment plans, slaughter tips and marketing suggestions this is the one book you need to raise up to 20,000 birds per year with much less work than you thought was possible. Meat and egg chickens and turkeys. The book was produced with the assistance of the USDA Department of Sustainable Agriculture and Development (SARE). Companion video also available. From Back40Books:
http://www.back40books.com/store/prodinfo.asp?number=0-918779-00-6&variation=&aitem=4&mitem=17
See also:
http://www.free-rangepoultry.com/
"Free-range in a nutshell", "Home Processing of Chickens" and more.

"Range Poultry Forum Magazine: The Journal of Producing, Processing and

Marketing Premium Quality Chicken, Turkey and Eggs" -- valuable information for ANY grass-based poultry producer regardless of system. Regular features on producers, hatchery profiles, direct marketing, predators, processing and more. Irregularly published; subscription is for four issues. Back issues available.
https://raju.safe-order.net/free-rangepoultry/p53.html

"Pastured Poultry Profits" by Joel Salatin, Allan Nation, Vicki H. Dunaway (Editor), reissue 1996, Chelsea Green, ISBN 0963810901
A cost-effective way to "get back to nature" in farming, providing healthy food at the same time.

Joel Salatin advances one of his mobile broiler coops on his farm in Virginia (T.L. Gettings, Rodale Images)

Covers all aspects of pasture-grazing chickens. Salatin says pastured poultry with mobile pens produce a safer, more environmentally sound and tastier bird. For the farmer, it's also a more satisfying, wholistic, economically beneficial and integrated system. Salatin sets out a workable guideline for starting your own operation: "A couple working 50 hours a week for six months a year on 20 acres can NET $25,000-$30,000." Getting started, pasturing, processing, marketing, problems, and troubleshooting. Makes poultry a cottage industry once again. From Fertile Ground Books:
http://www.agaccess.com/cgi-bin/webc.cgi/~fg/st_prod.html?p_prodid=CHG025&sid=24BCM@l
From Chelsea Green:
http://www.chelseagreen.com/DP/Polyface/PasturedPoultryProfits.htm

"Profitable Poultry: Raising Birds on Pasture" published by USDA's Sustainable Agriculture Network (SAN) -- Features farmer experiences plus research in a 16-page guide to raising chickens and turkeys using pens, movable fencing and pastures. For the newcomer or just-initiated, touches on production, processing, marketing and resources for poultry production. Free online:
http://www.sare.org/publications/poultry.htm

Plans for Building a Greenhouse-Style Pasture Broiler Pen. An interesting variation on Joel Salatin's poultry pasture pen by Maine grazier Chris Bailey, with a picture and construction details. "This structure will allow you to hang a 5 gallon waterer from the center purlin; didn't blow away in 50 mph winds; allows the degree of shade, wind, and rain protection to be easily modified by rolling up or down the plastic sides, or by covering one end in cool or windy weather; and allows easy entry and exit to feed, put in/take out birds. Not inexpensive, though," Maine says. Probably heavy too. It uses nine 10ft lengths of 3/4" electrical conduit. Why not try 1" PVC water pipe? Schedule 40 for strength.
http://www.bright.net/~fwo/sub10.html

Learning to Drive a Chicken Tractor
Photos and details of a chicken tractor here, but no plans -- no real need for plans, these are easy to make. Lightweight, easy to move, fine for 6-8 birds.
http://www.gsu.edu/~biojdsx/fowl/tractor.htm

Mulligan Creek Poultry Farm in Canada has more information on pasturing poultry, forage, and designs for a cheap and simple chicken tractor.
http://siteupgrade.com/poultry/

PasturePoultry email mailing list, for anyone with an interest in raising poultry on pasture for meat and egg production.
Subscribe: PasturePoultry-subscribe@yahoogroups.com
Unsubscribe: PasturePoultry-unsubscribe@yahoogroups.com
Post message: PasturePoultry@yahoogroups.com
List url:

http://groups.yahoo.com/group/PasturePoultry
Big, searchable archives at:
http://groups.yahoo.com/group/PasturePoultry/messages

Free-Range Poultry & Back40Books mailing list:
http://www.free-rangepoultry.com/maillist.htm

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Farming with animals

Aquaculture for small farms

A pond on a small farm can mean much better all-round farm integration and greater overall production. Apart from their use for ducks and geese, ponds can raise a useful supply of fish.

Plant and animal wastes fertilise the pond and/or feed the fish, sludge from the pond fertilises the croplands to raise more plants and animal-feed.

(ICAAE)

Ponds are also useful for waterharvesting in dry areas, storing water as a resource for the farm while being used for fish-raising. And ponds are often a viable land-use for marginal land or poor land. Even a small pond in a backyard can be a worthwhile source of food.

Aquaculture resources

"Small Scale Aquaculture: A Guide to Backyard Fish Farming" by Steven D. Van Gorder, 1992, Rodale Institute, ISBN 0-9677732-0-2
Details and plans on how to raise, harvest, prepare, and store over 100lbs of fish in five months. This system is the result of eight years of research at the Rodale Research Center. A simple and efficient way to produce your own fish on a scale appropriate for a self-sustaining household. Makes home aquaculture as practical as gardening for providing healthy food for a family. Features an ecologically sound recirculating system designed for low energy and low water use made from readily available materials. From Rodale Institute Bookstore: http://rodaleinstitute.org/bookstore/products/farm_books/3.html

"How to Grow Fish in the Mountains" by Joseph E. Richter, 1999, ECHO
Richter is a missionary-biologist working with FARMS in the Philippines. Written for the farmer. Simple and practical information, useful illustrations. "For every kilogram of

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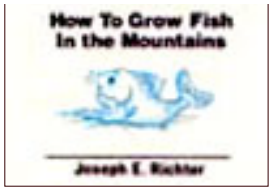
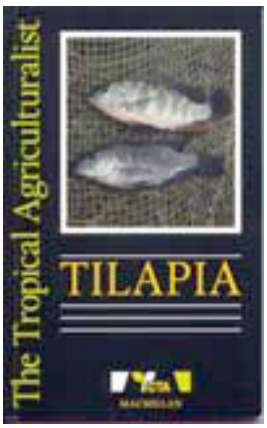


fish in your pond you can add 80-160 grams of wet manure daily. If your manure is dry, add only 20-40 grams. Sunny days are best for manure application. The morning is the best time to manure, so the nutrients can be used during the sunny part of the day. Afternoon application can cause a loss of oxygen during the night which can kill the fish." Why grow fish, common cultured fish, pond construction, fingerlings and their production, sexing brood fish, predators, fertilizing and feeding, integrated fish farming, harvesting, common mistakes. From ECHO's Global Bookstore: http://echonet.org/shopsite_sc/store/html/HowToGrowFishInMountains.html



"Tilapia" by J.C.V. Arrignon, 1998 Guide to farming tilapia: tilapia breeding, farming systems, health and environment, construction of farms and farm management, integrated farms. Clear, easy-to-read style, many photographs and diagrams. From ECHO's Global Bookstore: http://echonet.org/shopsite_sc/store/html/Tilapia.html

Water Harvesting and Aquaculture for Rural Development Series from the International Center for Aquaculture and Aquatic Environments (ICAAE), Department of Fisheries and Allied Aquacultures, Auburn University, Alabama. The ICAAE has worked on development in 97 countries. This is a useful series of 20 online booklets, clear and well-illustrated. Aquaculture, ponds, fertilization, feeding, tilapia, polyculture, rice paddies, intensive cage culture, water harvesting, more. http://www.ag.auburn.edu/dept/faa/icaaepub.html ICAAE home page: http://www.ag.auburn.edu/dept/faa/icaae1.html

From "An Introduction to Aquaculture"

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AquaNIC Aquaculture Network Information Center is intended to be a gateway to electronic resources in aquaculture. Maintained at Purdue University and supported by the US Department of Agriculture Extension Service. Searchable database, plus centralized search of a variety of other databases. Useful resources for beginners and discussion groups, categorized by Species and by Systems.
http://aquanic.org/

Roofwater Fish Farm Ideal For Learning -- Australian Vivienne Hallman is proving that urban fringe farmers can grow native fish successfully on natural foods. Most of the water can come from a home rooftop. Much of the fish food can be home-grown earthworms and insect larvae. Vivienne's project has shown how Australian native fish could be reared in a small area on worm-farmed kitchen scraps -- to give benefits to a vegetable or fruit tree garden. "One crop a year of silver perch is possible with unheated water," she said. Up to 50 fish a year can be raised in a 4,000-litre [900 gallons], unheated tank, to 350 to 400 gram size [about 1-lb]. "This means each of my five tanks is capable of raising 17 to 20 kg [37-44 lb] of silver perch under the non-stressful growing conditions I favour," Vivienne said.
http://www.cityfarmer.org/fishfarm.html

Fishing for Information -- links to Internet resources on aquaculture, fisheries, fish farming, shrimp, water resources, etc, from the Institute of Aquaculture at Stirling University in Scotland.
http://www.stir.ac.uk/aqua/Fishing/Fishing.html

The **FishBase Global Information System on Fishes** was developed at the International Center for Living Aquatic Resources Management (ICLARM) in collaboration with the FAO. Web-based searchable information and pictures on over 20,000 fresh and saltwater fish. Common name, scientific name, location, biology, culture, references, more (25,530 species, 71,000 synonyms, 110,000 common names, 28,000 pictures, 21,000 references).
http://www.fishbase.org/

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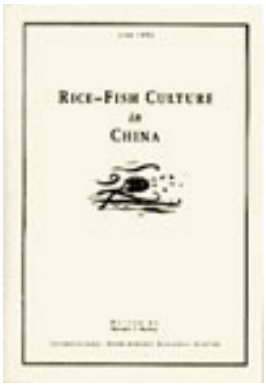
Japan

"Chinese Methods for Integrating Fish Culture with Crop and Livestock Farming" -- Integration of fish, livestock, and crop production in China has been refined over 2,000 years. The system recycles resources, reduces organic pollution (livestock and poultry manure are good organic fertilizers for fish farming), and combines fish farming with mulberry cultivation for raising silkworms. The silkworm pupae are used as fish feed, and the worm faeces and wastewater from silk processing as pond fertilizers. Pond silt is used as fertilizer for fodder crops, which can in turn be used to feed livestock, poultry, and fish.
http://www.idrc.ca/nayudamma/fishcul_30e.html



"Rice-Fish Culture in China" edited by Kenneth T. MacKay, IDRC, 1995, 240 pp, ISBN 0-88936-776-0, $35
Raising fish in rice paddies brings to farmers in Asia an important source of protein, as well as extra income. Biological and ecological aspects of rice-fish culture, and the economic and social dimensions. Full text online:
http://www.idrc.ca/acb/showdetl.cfm?&DID=6&Product_ID=484&CATID=15

"**Duckweed -- a potential high-protein feed resource for domestic animals and fish**", by R.A. Leng, J.H. Stambolie and R. Bell, Centre for Duckweed Research & Development University of New England Armidale, NSW Australia, Livestock Research for Rural Development, Volume 7, Number 1, October 1995 -- "... duckweeds yield 10-30 ton DM/ha/year (dry matter per hectare per year) containing up to 43% crude protein, 5% lipids and a highly digestible dry matter. Duckweeds have been fed to animals and fish to complement diets, largely to provide a protein of high biological value. Fish production can be stimulated by feeding duckweed to the extent that yields can be increased from a few hundred kilograms per hectare/year to 10 tonnes/ha/year."
http://www.cipav.org.co/lrrd/lrrd7/1/3.htm

The Integrated Tilapia & Duckweed Farming System -- The fish and the waters of the tilapia growout ponds provide the nutrients upon which the duckweed will thrive. In turn, the duckweed removes unwanted nutrients and waste products from

the system, converting the nutrients into plant biomass. This plant biomass, in turn, becomes a high protein food for the tilapias. While all this is going on, water within the integrated system is conserved and purified. The entire system is a natural and sustainable approach to aquaculture.
http://www.fishfarming.com/recirc.html

Duckweed Aquaculture -- A New Aquatic Farming System for Developing Countries, Paul Skillicorn, William Spira & William Journey, (1993) The World Bank -- "The PRISM Group initiated a pilot project in Bangladesh to develop farming systems for duckweed and to test its value as a fish feed. The results of the pilot operations were extremely promising; production of duckweed-fed carp far exceeded expectations, and dried duckweed meal provided an excellent substitute for soy and fish meals in poultry feeds. Duckweed could be grown using wastewater for nutrients, or alternatively using commercial fertilizers. Duckweed-fed fish production does not depend on mechanical aeration and appears to be significantly more productive and easier to manage than traditional pond fish culture processes." Full text online:
http://www.prismusa.homestead.com/files/Duckweed.htm
Color photos by Gregory D. Rose
http://www.fes.uwaterloo.ca/u/gdrose/image/prism.html

Massive **Fish FAQ** from the Northeast Fisheries Science Center -- plus a page of other fish FAQs. Do fish sleep? Do they chew their food? Everything about fish, as well as lobsters, shrimp, crabs, whales, turtles, porpoises, clams.
http://www.wh.whoi.edu/faq/index.html

"On-Farm Fish Culture", Agrodok No. 21, 1998, Agromisa Foundation
Crops or animal husbandry can easily be integrated with fish culture, with total production higher and more efficient than farms which haven't been integrated. Step by step strategy: principles of integrated fish culture and the use of plant material as fish feed and/or fertilizer, factors influencing the biological system in a fish pond, integration of fish culture with rice culture or several kinds of livestock production (pigs, poultry, ducks and geese, other livestock), many examples of possible combinations, by-products use, animal manure, using slurry from the pond as fertilizer for crops.
http://www.antenna.nl/~agromisa/agrodok/ad21.html

"Small-Scale Freshwater Fish Farming", Agrodok No. 15,

1996, Agromisa Foundation
Basic information for beginners. Principles of fish farming, site selection and choice of fish farm type. Detailed description of how to set up a small-scale fish farm for subsistence to provide daily protein requirements. Fish farming practises, choice of species, nutrition, health, reproduction, harvesting. Pond construction (appendix) and maintenance. Focus is on carp, tilapia, catfish.
http://www.antenna.nl/~agromisa/agrodok/ad15.html

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Controlling weeds and pests

"Pests do not arise because of a deficiency of pesticide in the environment any more than headaches result from a lack of aspirin in the blood stream. We get headaches because of the way we conduct our lives, and we get pests in the fields because of the way we manage them."
-- Hill, S.B. and J.A. Ramsay. 1977. **Limitations of the energy approach in defining priorities in agriculture** (in Lockeretz, W. (ed.) Energy in Agriculture), full text online: http://eap.mcgill.ca/Publications/EAP18.htm

"Even with the 10-fold increase in insecticide use in the United States from 1945 to 1989, total crop losses from insect damage have nearly doubled from 7% to 13%". (David Pimentel, Professor of Insect Ecology and Agricultural Sciences at Cornell University.)

Weeds

What are weeds? There are lots of vehement definitions -- they're pests, enemies, noxious, evil, treacherous, say gardeners and farmers. The biosphere's view, which might be more important, is that gardeners and farmers who fight weeds are the enemy because they damage the soil. Weeds are the frontline troops nature uses to repair damaged soil. If you don't want to fight weeds then don't damage the soil.

"Weeds are evidence of nature struggling to bring about natural succession," says Preston G. Sullivan, Technical Specialist with the Appropriate Technology Transfer for Rural Areas (ATTRA) in **"Principles of Weed Management for Croplands"**. "When we clear native vegetation and establish annual crops, we defy ecological succession. Man is, in effect, holding back natural plant succession, at great cost in weed control."

Sullivan says the answer is more biodiversity: "Stability through biodiversity is one of nature's fundamental rules."

In effect, the weeds are trying to turn your land back into a forest.

"What are the main principles underlying Nature's agriculture? These can most easily be seen in operation in our woods and forests. Mixed farming is the rule: plants are always found with animals: many species of plants and of animals all live together." (From Chapter 1, Introduction, "An Agricultural Testament", by Sir Albert Howard)

Increased biodiversity and good soil fertility maintenance solve weed problems. Some weeds grow to cover an exposed soil that's vulnerable to erosion and run-off -- nature hates exposed soil. So cover it yourself, with a mulch, or better, with a "living mulch" composed of a diversity of

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close-planted crops. Other weeds are deep-rooting plants that go down to the subsoil to collect fresh minerals when the topsoil runs out of them. Composting will maintain topsoil minerals. It's also a good idea to leave some of them growing -- they're good "companion plants" for your crops and they're good for the soil.

"We have seen some dramatic shifts/reductions in weed populations as soil has been under organic management longer and as fertility problems are corrected.

"For instance, quackgrass and nutsedge have all but disappeared from our fields in the past 5 years as we've been farming organically and been paying close attention to soil fertility balance. They are still present in thin patches when we plow, but with so little vigor that they don't show in the crop afterwards.

"Other whole classes of weeds, such as summer annual grasses like foxtail, panicum, and barnyard grass, have also disappeared.

"Some of the weeds, such as velvetleaf (buttonweed) and lambsquarters, while still present are growing with greatly reduced vigor and smaller populations." -- Organic farmer Klaas Martens, USA

"Most of the plants that I call weeds are involved in the primary stages of natural succession," writes Kim Wilkinson in AgroForester. "They are medicine for the soil, repairing it and revitalizing life. Succeeding weeds is about stepping-up the process of succession. Weeds are experts in the process of succession, and great soil indicators as well, so I always look to them to learn what is appropriate. This means mulching and filling the space with appropriate plants (groundcovers, crop trees and other vegetation), creating a healthy system with no room and no need for voracious weeds to modify it. Some of the most aggressive weeds need full sun and low fertility to thrive; by increasing shade, organic matter and soil health they will disappear." (**"Working with Weeds in the Tropics -- If You Can't Eat Them, Succeed Them!"**)
http://www.agroforester.com/articles/Working_with_Weeds.html

Striga -- witchweed -- is one of the worst weeds in the world. It's a parasitic weed of cereal crops and it can cost subsistence farmers in Africa two-thirds of their crops. Striga roots invade the roots of cereal plants and consume the host plant's sap. By the time the flowers appear, it's already too late: the damage is done. Each striga plant yields thousands of seeds, which survive in the soil for up to 20 years.

Biological controls are now being used, but striga is basically the same as other weeds, and the same rules apply: "Striga thrives under conditions of low soil fertility and decreasing plant diversity." (ECHO Development

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Notes, Issue 59, February 1998)

Striga kills cereals

"Experiments in western Kenya show enormous potential for some common weeds to increase soil fertility in cropland. Fast growing weeds that produce a lot of biomass are collected both on- and off-farm and used as green manure. Compared to commercial fertilizers, application of high amounts of Tithonia or Lantana green manure had very good results on growth and yield of maize. An additional benefit of the green manure was a significant reduction of the presence of the parasitic weed Striga (by almost 70%)" -- Rik Thijssen, **"Weeds and trees"**, ILEIA Newsletter Vol. 11 No. 3 (October 1995): "We Love Weeds".

"The best way to dispose of a weed is to make use of it, to promote it to the level of wanted plants," says Thijssen. Some Third World farmers simply wouldn't survive without their "weeds"! Thijssen's article explains why:
http://www.oneworld.org/ileia/newsletters/11-3/11-3-20.htm

"It is not unusual for one plant thus to prey on another, which, we may be sure, invites the enemy only because it is starved or in some way weakened. The Indian cultivator knows this and at once supplies manure if he finds his sugar cane preyed upon by a species of Striga; the Striga disappears... The best proof has been established by some formal experiments carried out in South Africa on witch-weed (*Striga lutea*), which constantly and severely infects the maize crop; dressings of humus at the rate of ten tons to the acre proved a complete cure, and the disease-free crop formed an excellent contrast to the control plot alongside, which was a red carpet of the weed. (Experiments of Mr. Timson reported to *The Rhodesia Agricultural Journal*, October 1938, and confirmed by official experiments at the Rhodesian Witch-weed Experimental Farm: see An Agricultural Testament, Ch. 5 and Compost News Letter, No. 5, pp. 17-18.)" -- **"The Earth's Green Carpet"** by Louise E. Howard, 1947, Faber & Faber, London: Chapter 9. Disease as Censor. Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

"... Striga, a parasitic plant that wrecks $10 billion worth of maize crops every year, threatening the livelihoods of 100 million Africans. Weeding Striga is one of the most time-consuming activities for millions of African women farmers, says Ziadin Khan, of the International Centre for Insect Physiology and Ecology in Nairobi. But he has an antidote: another weed, called Desmodium. "It seems to release some sort of chemical that Striga doesn't like. At any rate, where farmers plant Desmodium between rows of maize, Striga won't grow." Khan's cheap fixes are spreading like wildfire through the fields of east Africa. Trials on more than two thousand farms are finished." -- **"An Ordinary Miracle"**, New Scientist, February 3, 2001

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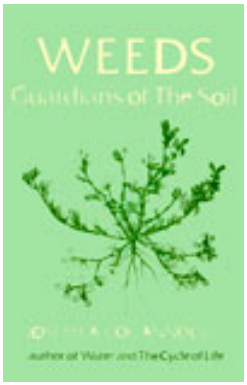
See also:
Quack grass
What are weeds? -- Water hyacinth and duckweed

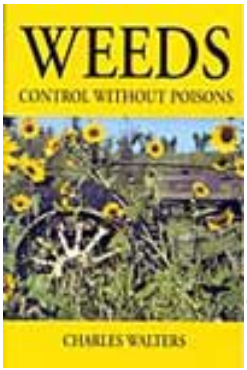
Weed control resources

Principles of Weed Management for Croplands -- Agronomy Systems Guide, by Appropriate Technology Transfer for Rural Areas (ATTRA). "Weeds are invited guests into agricultural fields as the result of management decisions and defying nature's principles. Managing croplands in tune with nature's principles makes for fewer and less costly weed problems. Strategies which utilize allelopathy, intercropping, crop rotations reduce weeds considerably." A weed-free design, other weed control strategies. About 8,000 words, and well worth the read. "First, Free Your Brain".
http://www.attra.org/attra-pub/weed.html

Insects and Weeds on the Web -- many resources with information on biological controls and how to control pests and weeds organically, at the Don't Panic Eat Organic site.
http://www.rain.org/~sals/bugs.html

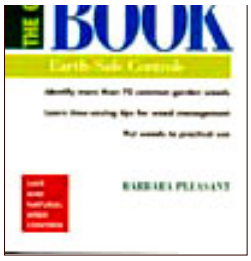


"Weeds -- Guardians of the Soil" by Joseph A. Cocannouer, Devin-Adair, 1950.
Professor Cocannouer, who taught biology and conservation for 50 years, demonstrates how the controlled use of weeds is sound ecology, good conservation and a boon to the gardener. Weeds as indicators of soil conditions, weeds as companion plants.
Full text online at the **Small Farms Library**



"Weeds: Control Without Poison" by Charles Walters Jr., 2nd Edition 1991, Acres USA
Expanded edition of a classic book on weeds -- specifics on a hundred weeds, why they grow, what soil conditions encourage them or stop them, what they say about the soil, and how to control them without poisons. Walters is the publisher of Acres USA, the journal of eco-farming. He takes an ecology-centred, scientific approach to weeds and their use and control. From Acres U.S.A.:
http://www.acresusa.com/books/closeup.asp?prodid=6&catid=10&pcid=2

"The Gardener's Weed Book: Earth-Safe Controls" by Barbara Pleasant, 1996, Storey Books, ISBN 0882669214



Safe and natural weed control. Identifies more than 70 common garden weeds, with tips for weed management and putting weeds to use. Weeds, grassy weeds, vining weeds, family relations. From ECHO's Global Bookstore: http://echonet.org/shopsite_sc/store/html/Gardenersweedbook.html

"Future Harvest: Pesticide-Free Farming" (Our Sustainable Future, Vol 5) by Jim Bender, 1994, Univ of Nebraska Press, ISBN 080321233X "For me, one of the sweetest moments of my life came in 1980, when I eliminated all pesticide use on my field crops, thereby successfully matching my practice with my convictions." Bender converted his 642-acre Nebraska farm to organic production over a decade. He says chemical farming damages the water supply and that applying herbicides to soybeans actually encourages weeds. He makes a persuasive case for organic methods: modern organic farming makes good use of modern technology and is not a step back to a century ago. Bender dismisses charges that alternative agriculture is less productive, and if it's more labor-intensive, it's because of the necessity to include livestock (and manure production) in the operation.

Insect pests

> **-- "Pesticides are the badge of the amateur" -- an organic grower**

"The pests are my professors," wrote Sir Albert Howard, founding father of the organics movement. Pest attack showed him where the soil fertility needed attention. Plants growing in fertile soil have healthy immune systems and can repel pest attack. Where this doesn't happen, the soil is unbalanced. Correcting the problem restores plant health and the pests depart.

Using poison sprays is futile, and worse: the poisons also kill beneficial insects which naturally control the pests. Most of today's major crop pests have actually been *caused* by pesticides which have wiped out their natural predators.

Scientists at the University of Georgia found that plants send out specific signals for parasitic wasps to come to their aid when under attack by plant-eating insects. Parasitic wasps are the natural enemies of some of the pests. The scientists used cotton, tobacco and maize plants, all of which emitted the signals for the wasps. Each species of wasp is only parasitic on certain pest species. The signal sent out by the plants attracted the very species of wasp that parasitizes the attacking pests. (ECHO Development Notes, Issue 66, December 1999)

Eve Balfour, one of the founders of the organics movement, told how a commercial organic grower was visited by a team of plant pathologists

and entomologists from Cambridge University. "They knew it was an unsprayed holding and they came looking for disease and pests. They found isolated examples of everything they expected to find, but, as they put it, they failed to find a single case of crop damage." -- Lady Eve Balfour, **"Towards a Sustainable Agriculture -- The Living Soil"**, an address to an IFOAM (International Federation of Organic Agriculture Movements) conference in Switzerland in 1977. Online at: http://www.soilandhealth.org/01aglibrary/010116Balfourspeech.html

No pesticides

Rotenone is a safe and effective organic insecticide (biocide, pesticide) derived from derris roots, used by traditional societies in the east for centuries and approved for use by all organic associations. The effects are not persistent, it is biodegradeable and breaks down quickly into harmless by-products, and it is harmless to birds and mammals.

But most organic growers don't use it: less than 6% of the respondents to a US Department of Agriculture survey of certified organic vegetable growers reported using rotenone (American Journal of Alternative Agriculture, Vol. 13, No. 2, 1998).

"I don't think we are unique among experienced organic growers in using very little intervention in pest management." (Organic grower, US)

"I, too, use no biocides. People who think you have to use biocides to farm assume incorrectly that organic farmers use botanical biocides. This is not the case. Very few organic farmers merely switch from synthetic to organic biocides. For some this may be a first step in the transition to organic growing, but it is not the rule.

"Organic farmers have shown that food crops can be grown with the same or more production per acre, with the same or less lost to pests, without using biocides or NPK (chemical) fertilizers." (Organic grower, US)

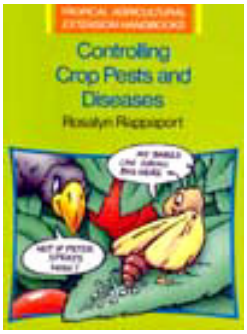
"The testing we have done so far here in the US and in Vietnam and China has shown that disease suppression, both foliar, limb and root, is more closely associated with mature compost that has a wide range of bacterial and fungal components...

"In Vietnam, there is a disease of citrus called "Greening Disease". It has become a major concern in Asia and now in the United States. No known cure. The solution to date has been to cut down the trees, burn the rubble and replant with a different crop. Our tests have regrown new foliage, sent the diseased trees into blossom and produced unaffected fruit. The same product has produced rice with no chemical inputs and no sign of disease. In Arizona and Arkansas, the same product has controlled cotton root, rot blight pythium and fusarium wilts and nematodes. In China, potatoes from

infected fields showed no signs of disease after using the same product.

"I could go on and on. The point being, disease suppression seems to be a function of balance in the microbial population. It is the imbalance introduced by modern farming practices that create the problem."
-- Phil Fredericks
http://www.ecticompost.com
("WASTENOT Organic Waste Collection, Processing, Composting" list, 5 Jan 2001)

Insect control resources



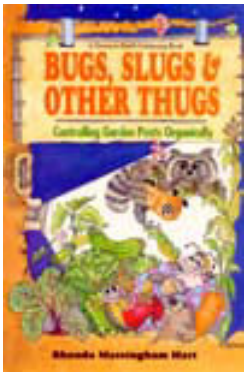
"Controlling Crop Pests and Diseases" by Rosalyn Rappaport, 1992
Covers pest and disease damage, causes and controls. Manual and cultural techniques, Integrated Pest Management. Village-available insecticides: cheap, available and much safer alternatives to chemical pesticides, using improvised ingredients. Also keeping animals out of the garden with hedges, ditches and strips, windbreaks. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/ControllingCropPestsDiseases.html

"Natural Pest & Disease Control" by Henry Elwell & Anita Maas
Tried and tested methods to establish a long-term healthy balance within the farm envirnment. "There are many safe, natural and simple methods of protecting plants. In the long term, modem chemical pesticides increase the pest and disease problem. They do not solve it. Modem chemical pesticides are poisonous. They are harmful to human health and destroy the on-farm and wider environment. Farmers and gardeners alike should find this book appropriate and useful because it provides welcome, environmentally safe alternatives to replace agro-chemicals." It also offers a way out for poor small-scale farmers with no means of controlling pests and disease. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/Naturalpestdiseasecontrol.html

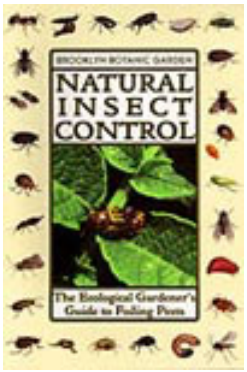
"The Gardener's Bug Book: Earth-Safe Insect Control" by Barbara Pleasant, revised edition 1994, Storey Books, ISBN 0882666096
This is an updated version of The Bug Book, written by organics specialists Helen and John Philbrick in 1974. Covers beneficial insects, formulas for organic controls and over 70 common insect pests. How to work with nature to reduce pests while producing bountiful,

environmentally safe and chemical-free harvests. The challenge is "To try to synthesize nature's kingdom". From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/GardenersBugBook.html

"The Organic Gardener's Handbook of Natural Insect and Disease Control" by Barbara W. Ellis & Fern Marshall Bradley, editors, Revised edition 1996, Rodale, ISBN 0875967531
Complete guide to pest and disease control without chemicals. Problem-solving diagnostic encyclopaedia covers more than 200 plants. Over 350 color photos for quick identification of pests, beneficial insects and plant diseases.
http://echonet.org/shopsite_sc/store/html/OrganicGardenershandbook.html



"Bugs, Slugs & Other Thugs: Controlling Garden Pests Organically" by Rhonda Massingham Hart, 1991, Storey Books, ISBN 0882666649
Help in identifying pests and a host of practical, safe solutions, ranging from the latest scientific advances to old folk remedies that really work. "Forced to adapt in the face of chemical attacks, insects mutated and survived. They developed resistance to pesticides, making it necessary to apply more and stronger chemicals, with ever more severe consequences. With their natural enemies exterminated, insects that had rarely caused problems in the past suddenly reached outbreak proportions. Clearly, it's time to seek alternatives to pesticides." Thorough treatment. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/Bugsslugsotherthings.html



"Natural Insect Control: The Ecological Gardener's Guide to Foiling Pests", Warren Schultz (Editor), 1995, Brooklyn Botanic Garden, ISBN 0945352832
Pick a pest, and you can almost surely find a natural control for it -- one that won't poison you, your kids or your pets, won't cause cancer and won't wreak ecological havoc. This handy guide is designed to make natural, non-toxic pest control as easy as possible. From EDF Bookstore:
http://www.environmentaldefense.org/EarthMall/Bookstore/envgardening.html

"Producing Food Without Pesticides", by L. Fuglie, 1998
A guide to the use of various plants and approaches to crop pest control in West Africa, easily accessible to

small farmers and gardeners, which can reduce or eliminate dependence on chemical pesticides. Many of these approaches have long been in use within the region. With 67 local solutions to crop pest control. The most common insect pests and plant diseases are described, along with suggestions for ways to combat them. Composting and maintaining soil fertility are included. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/ProducingFoodWithoutPesticides.html

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Nutrition and Physical Degeneration by Weston A. Price, 1939

The Wheel of Health by G.T. Wrench

The Restoration of the Peasantries, With especial reference to that of India by G.T. Wrench

Reconstruction by Way of the Soil by G. T. Wrench

Towards a Sustainable Agriculture -- The Living Soil by Lady Eve Balfour

Weeds -- Guardians of the Soil by Joseph A. Cocannouer

Seaweed and Plant Growth -- from "Seaweed in Agriculture and Horticulture", by W.A. Stephenson, Faber & Faber, 1968

This Famishing World by Alfred W. McCann

Pay Dirt -- Farming & Gardening with Composts by J.I. Rodale, 1946

The Saccharine Disease: Conditions caused by the Taking of Refined Carbohydrates, such as Sugar and White Flour by T. L. Cleave, 1974

The Medical Testament

Voedzame Traditionele Voeding -- Dutch translation of "Nourishing Traditions", Sally Fallon and Mary Enig, 2001

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Friend Earthworm: Practical Application of a Lifetime Study of Habits of the Most Important Animal in the World by George Sheffield Oliver, 1941

Mycorrhiza

Trees and Toadstools by M.C. Rayner, 1945

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Tree Crops: A Permanent Agriculture by J. Russell Smith

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Farm-scale ethanol fuel production plant -- the Gildred/Butterfield Fuel Alcohol Plant

The Butterfield Still -- the FSB Energy Fuel Alcohol Plant.

Mother Earth Alcohol Fuel, The Mother Earth News, 1980

The Manual for the Home and Farm Production of Alcohol Fuel, by S.W. Mathewson

The Sunflower Seed Huller and Oil Press, by Jeff Cox

The Soil and Health

Albert Howard

An Agricultural Testament by Sir Albert Howard, Oxford University Press, 1940.
This is the book that started the organic farming and gardening revolution, the result of Howard's 25 years of research at Indore in India. The essence of organics is brilliantly encapsulated in the Introduction, which begins: "The maintenance of the fertility of the soil is the first condition of any permanent system of agriculture." Read on! Full explanation of the Indore composting process and its application. Excellent on the relationship between soil, food and health. Full text online.

A review of the work of the founder of the organic farming movement, **Sir Albert Howard**, by Keith Addison: "I'll never finish reading this book -- I've read it through three times and referred to it scores of times, and each time I learn something new. Meanwhile I've read Howard's other books, and a lot of his papers and essays, and a great deal besides. I've talked to many other people, seen many other organics projects, farms and gardens in many different areas; I've used these techniques myself in a variety of settings, and it all confirms Howard's thesis. I still see it mostly in the Third World development context. To me organic farming is THE basic appropriate technology for rural areas. It's the best place to start -- get this

Solar box cookers
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Sisters of silk
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Ichijima
Japan

right and so many of the other problems will simply vanish." Includes a short bibliography and links to Howard's major works and some of his published papers.

Weston A. Price

"Nutrition and Physical Degeneration" by Weston A. Price, 1939; 1945 Price-Pottenger Nutrition Foundation, 1970, 1989
Weston Price was truly "the Charles Darwin of nutrition". He discovered what health is made of, and proved it beyond any doubt. In the early 1930s Price travelled more than 100,000 miles to study the diets and health of isolated primitive peoples all over the world, at a time when such communities still existed -- people "who were living in accordance with the tradition of their race and as little affected as might be possible by the influence of the white man". What he found makes fascinating reading, turning many of our modern ideas on their heads. Then Price compared these communities to other, less isolated groups of the same peoples, exposed to the "trade foods" produced by industrial society (processed foods grown by synthetic farming methods), in the shape of the "white man's store". He found it takes only one generation of eating industrialized food to destroy health and immunity. But he leaves us with the promise of regeneration -- thwarted health can be recaptured. See Journey to Forever's **review** of this extraordinary book. See the Weston A. Price Foundation for more information:
http://www.westonaprice.org/

G.T. Wrench

The Wheel of Health by G.T. Wrench, Daniel, 1938
Dr. Wrench's classic exploration of the Hunza, a mountain people renowned for their longevity and vigor. By approaching the problem of disease from the angle of a study of a perfectly healthy people, Wrench shows that health depends on environmental wholeness, of which a whole diet is the vital factor, and that a whole diet means not only the right sorts of foods, but their right cultivation as well. An examination of the agricultural technique of the most successful cultivators of East and West shows what an essential part of the wheel of health -- from man to soil, from soil to plant, from plant to man -- is the farmer's renewal and protection of the soil. Full text online. Scanned by Steve Solomon of the Soil and Health Library.

The Restoration of the Peasantries, With especial

reference to that of India by G.T. Wrench, Daniel, 1939.
Argues, in Wrench's wise and admirable style, that the health -- indeed, the very continuation of our civilization -- depends on the health and prosperity of agricultural producers, and shows how the thrust of finance-based civilization has worked to destroy their very existence. A fascinating look at how villages work -- and how they're reduced to poverty and worse. Full text online. Scanned by Steve Solomon of the Soil and Health Library.

Reconstruction by Way of the Soil by G. T. Wrench, Faber and Faber, 1946
An outline history of the relation between civilization and the soil, by a most intelligent writer. A universal history of agriculture and a series of striking examples of the effects of civilizations upon their primary biological resources. Dr. Wrench states the essential principles of sound agronomy and gives examples of their fulfilment or violation in China, Mesopotamia, the Roman Empire, Islamic Spain, England, in Africa since the coming of the Europeans, in Egypt and India and the Dutch Empire, in the British colonies, in the U.S.S.R. and in the U.S.A. An eloquent plea for the recognition of natural laws in the symbiosis of soil and civilization. Full text online.

Eve Balfour

Towards a Sustainable Agriculture -- The Living Soil, by Lady Eve Balfour. This classic text on the organic movement is an address given by the late Lady Eve Balfour, author of the organics classic "The Living Soil and the Haughley Experiment", to an IFOAM (International Federation of Organic Agriculture Movements) conference in Switzerland in 1977.

Weeds

Weeds -- Guardians of the Soil by Joseph A. Cocannouer, Devin-Adair, 1950.
Professor Cocannouer, who taught biology and conservation for 50 years, demonstrates how the controlled use of weeds is sound ecology, good conservation and a boon to the gardener and farmer. Weeds as indicators of soil conditions, weeds as companion plants, weeds as hay and fodder, for opening up the subsoil, remineralizing the topsoil, for restoring worn-out and eroded land. A wise and liberating book!

Seaweed and Plant Growth -- from "Seaweed in Agriculture

and Horticulture", by W.A. Stephenson, Faber & Faber, 1968. "The whole chapter is packed with eye-opening information. It looks for instance as though the small quantity of seaweed meal I regularly add to my potting composts may play a part not only in nutrition and even in disease resistance but also in their crumb structure and water-holding capacity. Not only can these plants provide trace elements, growth substances and protection from diseases for their crops, but the seaweeds are ultimately also a potent source of soil nitrogen. Truly a useful 'workhorse'."
-- Moira Ryan, Organic Gardening Discussion List

Alfred W. McCann

This Famishing World by Alfred W. McCann, George H. Doran, New York, 1918
The subtitle says it all: "Food follies that maim and kill the rich and the poor -- that cheat the growing child and rob the prospective mother of health -- that burn up millions in treasure and fill untimely graves -- and the remedy." McCann was a journalist and food campaigner, and this is his story of what happens when food is divorced from its nature and function to become a mere industrial commodity. "Every pound of food juggled, changed, denatured or chemically treated is balanced by a pound of human flesh." Now more and more researchers are belatedly questioning the nutritional quality of our food, but most of them still only see a tiny part of the full picture McCann painted 84 years ago, and Price, McCarrison, the Cheshire medical panel, Pottenger, Cleave, Yellowlees and others after him. Full text online (with thanks to Kirk and Karen McLoren).

J.I. Rodale

Pay Dirt -- Farming & Gardening with Composts by J.I. Rodale, with an introduction by Sir Albert Howard, Devin-Adair, 1946
Inspired by the work of Albert Howard, J.I. Rodale bought a farm, founded Organic Gardening Magazine, as well as Rodale Publishing, worked tirelessly to introduce organic farming to the US, and wrote this book. A good wrap-up of the subject. Full text online.

T.L. Cleave

The Saccharine Disease: Conditions caused by the Taking of Refined Carbohydrates, such as Sugar and White Flour by T. L. Cleave, John Wright, 1974

Surgeon Captain T.L. Cleave, Director of Medical Research at the Royal Naval Medical School, whittled down the root cause of dozens of the ills of industrial societies to one simple factor, also noted by nutrition pioneer Sir Robert McCarrison: their dependence on refined carbohydrates -- the "master-disease". Full text online (scanned by Steve Solomon of the Soil and Health Library, book provided by Journey to Forever).

Medical Testament

The **Medical Testament** published by the 31 doctors of the Cheshire Panel Committee in England on March 22 1939 was a milestone in the development of the infant organic farming movement. It acknowledged great advances in the realm of cures, but rather the opposite when it came to prevention. It also explained why this was so, and offered the remedy, plus the proof of it: "A fertile soil means healthy crops, healthy animals and healthy human beings." This is a classic document, often referred to and reprinted in books and papers written at the time and subsequently, but now long out of print -- a lost classic. We tracked down a copy of the original pamphlet, plus some of the associated documents and publications -- 15 papers in all, virtually a book, all available here in full-text. Includes work by pioneer of nutrition Sir Robert McCarrison, organic farming founder Sir Albert Howard, Lionel Picton, Dr. G.T. Wrench, J.I. Rodale, Dr Walter Yellowlees, and some of the pioneers of organic farming. This is what organic growing is all about.
Introduction
Medical Testament

Voedzame Traditionele Voeding -- Dutch translation of **Nourishing Traditions**, Sally Fallon en Mary Enig, herziene 2de druk, Washington 2001. In de reeks van de werken van Weston A. Price, roept Nourishing Traditions veganisten en vegetariers op om een bepaalde mate van dierlijk voedsel - zoals ook goede biologische melk en eieren - te beschouwen als essentieel voor het menselijke leven. We kunnen dit niet kunstmatig vervangen, maar moeten ook streven naar biologisch voedsel van goede vruchtbare mineraalrijke bodem, en dit op de juiste manier bereiden. Men kan uit dit boek leren om betere voedselkeuzes te maken. Met toestemming voor de internetpublicatie van Sally Fallon. Vertaling Rob Hundscheidt en Christine Audenaert. Acrobat file, 556kb.

Earthworms

Friend Earthworm: Practical Application of a Lifetime Study of Habits of the Most Important Animal in the World by George Sheffield Oliver, 1941. Dr Oliver was one of the first to harness the earthworm to the needs of the farmer and gardener -- to make highly fertile topsoil for optimum crop growth, and to produce a constant supply of cheap, high-grade, live protein to feed poultry. He devised simple yet elegant and effective systems to bring costs and labour down and productivity up to help struggling farmers to make ends meet. Oliver had an observant and critical eye and understood Nature's round. His ideas on the nature of modern food and health (or the lack of it) are only now being confirmed, half a century later. A delightful book. Full text online.

My Grandfather's Earthworm Farm -- The story of a self-contained farm of 160 acres, maintained in ever-increasing fertility over a period of more than sixty years, through the utilization of earthworms. A true story related to Thomas J. Barrett by the late Dr. George Sheffield Oliver -- inspiring! From "Harnessing the Earthworm" by Dr. Thomas J. Barrett, 1947.

Eve Balfour on Earthworms -- Introduction to "Harnessing the Earthworm" by Dr. Thomas J. Barrett, 1947. Lady Eve Balfour was a key figure in the forming of the organic farming movement, and one of the founders of Britain's Soil Association. 2,400-word article on building topsoil with earthworms -- and why it matters.

Albert Howard on Earthworms -- Introduction to Darwin's "The Formation of Vegetable Mould through the Action of Worms with Observations on their Habits", Faber and Faber edition, London, 1945. The founder of the organic farming movement discusses the role of earthworms, Darwin's work, the work of Dr Oliver in the US, and much besides, in this 4,500-word introduction.

The Housefly by Professor Roy Hartenstein, School of Biology, Chemistry and Ecology, State University of New York College of Environmental Science and Forestry, Syracuse, New York, 1983. The use of houseflies in treating sewage sludge -- and for a free source of rich protein for poultry-feed.

Mycorrhiza

"Trees and Toadstools" by M.C. Rayner, D.Sc., Faber and Faber, 1945.
Dr Rayner can be credited with putting the mycorrhizal association on the agricultural map. Mycorrhizas are fungus-roots, a symbiotic relationship between plant roots and friendly soil fungi without which most plants cannot thrive, while many cannot even survive without their fungal partners. The fungus actually feeds the plant, and in return the plant feeds the fungus the products of the green leaf which the fungus is unable to make for itself. Enhanced by good humus maintenance and often damaged by chemical fertilizers and pesticides, the mycorrhizal association is fundamental to why organic growing works.
Introduction
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Tree crops

Tree Crops: A Permanent Agriculture by J. Russell Smith, first published 1929, copyright 1950 The Devin-Adair Company, ISBN 0-933280-44-0
This is the classic work on tree crops. Russell Smith was 50 years ahead of his time, writing the basic text on agroforestry long before there was such a thing. He travelled widely and saw it all coming. The best book about trees -- it's inspired generations of environmental activists. A highly readable blueprint for the development of high-yield tree crops showing that vast, untapped food sources can be harvested from common species of trees. Smith says agriculture must be "adapted to physical conditions," that "farming should fit the land." He observed worldwide the catastrophe of hill agriculture which he described so accurately as "forest-field-plow-desert." "*Tree Crops* made so much sense to me that I have never been the same since... As my work took me all over the world, everywhere I could see it, thanks to Russell Smith: Agriculture in mountainous, rocky, or dry regions is a disaster, but trees are salvation." -- E. F. Schumacher. Only the Introduction, Chapters 1, 2 and 3, and Chapters 24 and 26 are reproduced here in this online edition. Buy the book, it's a treasure-trove. From Island Press:
http://www.islandpress.org/books/Detail.tpl?cart=30831123971221&SKU=0-933280-44-0

Soil conservation

Conquest of the Land Through Seven Thousand Years
by W. C. Lowdermilk, U.S. Department of Agriculture, Soil Conservation Service, 1948 -- First published as USDA Bulletin No. 99, 1939.
Dr. Lowdermilk, the assistant director of the newly created United States Soil Erosion Service, wrote this classic report on agriculture and soil erosion in 1939. He studied the record of agriculture in countries that have been under cultivation since the earliest recorded times to see what the US could learn to avoid another Dust Bowl. He discovered that soil erosion, deforestation, overgrazing, neglect, and conflicts between cultivators and herdsmen have helped topple empires and wipe out entire civilizations. At the same time, he learned that careful stewardship of the earth's resources, through terracing, crop rotation, and other soil conservation measures, has enabled other societies to flourish for centuries.

Humanure

The Specialist by Charles Sale, illustrated by William Kermode, Putnam, ISBN 0911416005
The wonderful story of Lem Putt, country carpenter and specialist builder of privies. Lem actually existed, and Chic Sale knew him, and both lampoons him and respects him as "an artist in his way". Sale was an actor and "performed" this story hundreds of times, and by the time he wrote it (to copyright it in order to stop other actors stealing it) he had it honed to perfection. It's a rare delight. And it's more than that: Lem Putt knew his business. "There's a lot of fine points to puttin' up a first-class privy that the average man don't think about. It's no job for an amachoor, take you my word on it. There's a whole lot more to it than you can see by just takin' a few squints at your nabor's." This is what a water and sanitation engineer who works in developing countries said about it: "If I could recommend one course book for all wastewater engineers this would be it." Not just wastewater engineers -- Lem Putt's fine points should be everybody's fine points. Full-text online.

Man and Nature

The Soul of the White Ant by Eugène N. Marais, 1937
Eugène Marais is a forgotten genius. He was master of a science

that hadn't yet been invented; he postulated natural mechanisms and systems that were not identified by mainstream science for another 40 years. Neither science nor society has yet caught up with many of his findings and conclusions. As a natural scientist it was the mind of man, the human psyche, that preoccupied Marais. To unlock the key to its nature it was to nature that he turned, rather than to other humans. He followed two parallel paths, the study of the animals most like humans, the primates, and the study of creatures that could hardly be more alien to us, termite colonies -- white ants. In both fields his findings were revolutionary. He developed a fresh and radically different view of how a termite colony works, and indeed of what a termite colony is, far in advance of any contemporary work. This is *The Soul of the White Ant*, and it's about much more than termites. A rare gem, and a rare delight to read.

Farm Gumption

Handy Farm Devices and How to Make Them by Rolfe Cobleigh, Orange Judd Company, 1910
Not just nostalgia -- Cobleigh's devices and techniques were good answers to common farm problems and they're just as functional and useful now as they were then. Make your own workshop tools, a simple fence post and stump-puller, fences and gates that don't sag, building a farmhouse, barns and outbuildings, a bicycle-powered washing machine, a dog-powered pump, a lightweight orchard ladder, a portable chicken coop, a stone boat (for moving stone) and much more. Cobleigh's out to save you time and money -- a treasure for small farmers or homesteaders and anyone wanting to be more self-sufficient. Illustrated, good old-style writing, punctuated with quotes from Shakespeare or a local farmer, whichever's apt. Workshop and Tools, The Steel Square, In and Around the House, Barns and Stock, Poultry and Bees, Garden and Orchard, Field and Wood, Gates and Doors, When We Build, Worth Knowing. Full text online. With thanks to Kirk McLoren.

Profitable Poultry Production by M. G. Kains, Orange Judd Company, 1910
"Poultry production is commonly practiced on every farm, but *profitable* poultry production so far as the farm is concerned, is rare indeed. No one, as a rule, has better natural conditions for poultry raising than has the farmer. It is only a matter of embracing opportunities that is wanting." Kains tells you how -- how-to's, plans, studies, and sound common-sense from long before confinement systems. The plans and drawings of coops

and housing systems are a treasure in themselves. Kains was Poultry Editor of the American Agriculturist Weeklies, and author of the classic "Five acres and independence: a practical guide to the selection and management of the small farm", published in 1935 and still in print. Many thanks to Kirk McLoren for scanning this book for us. Full text online.

Energy

Methane Digesters For Fuel Gas and Fertilizer, With Complete Instructions For Two Working Models -- by L. John Fry, Santa Barbara, Calif. 93103, © 1973, Eighth Printing (out of print). Excellent manual on making and using methane -- biogas. Fry developed his techniques while running a pig farm in South Africa, designing the first full scale displacement methane plant. Good information on integrating biogas production with gardening and farming, and with pond-culture food production. Designs for a Sump Digester using 55-gal oil drums and an Inner Tube Digester. With thanks to Kirk McLoren.
DjVu version: This file requires the DjVu plug-in reader, available as a free download (about 1Mb) for Windows, Linux, Solaris and Macintosh. View online or download the file for offline viewing.
Download DjVu here:
http://www.lizardtech.com/download/?f=0&d=1
DjVu FAQ here:
http://www.lizardtech.com/support/faq/general_djvu.php

Interview: L. John Fry
Interview: Ram Bux Singh

Nepal Biogas Plant -- Construction Manual. Construction Manual for GGC 2047 Model Biogas Plant. With Dutch and German support, Nepal's Biogas Support Programme has built 95,400 biogas plants in 10 years, with potential for half a million more. These are fixed dome biogas plants, designed in Nepal. Sizes are household-scale from 4 to 20 cubic metres. The feedstock is cattle dung and water (but other feedstocks will work just as well). For instance, the 4-cubic-metre plant requires input from 2-3 cattle, the 10-cubic-metre plant needs 6-9 cattle. This manual includes full construction details, plans and data. With thanks to Olivier Morf.

Jean Pain: France's King of Green Gold -- Frenchman Jean Pain built a home-made power plant that supplies 100% of

the his energy needs. The core of the system is a 50-ton compost mound, three metres high and six across, made of pulverized tree limbs and underbrush. Buried inside the compost is a 4-cubic-metre sealed steel tank 3/4-full of the same compost, producing methane -- bio-gas. Tubes connect the tank to a pile of 24 truck-tyre inner tubes, the gas reservoir. Pain uses the gas to cook all the food, fuel a truck and produce electricity, via a methane-fuelled internal combustion engine that turns a generator. Another tube runs from a well and into the heap, with 200 metres of tubing wound round the tank, the water emerging at 60 deg C at 4 litres a minute, enough for central heating, the bathroom and the kitchen. The compost heap continues fermenting for nearly 18 months, and then yields 50 tons of natural fertilizer. (With thanks to Ramjee Swaminathan.)

Micro Cogeneration: 21st Century Independent Power -- How to Design and Construct Your Own Independent Power System -- First Edition, 1993, by Kirk McLoren, Independent Power, Billings, Montana. Covers all aspects of this most useful subject, from thinking about it to putting it all together, and everything in between.
This file requires the DjVu plug-in reader, available as a free download (about 1Mb) for Windows, Linux, Solaris and Macintosh. View online or download the file for offline viewing.
Download DjVu here:
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DjVu FAQ here:
http://www.lizardtech.com/support/faq/general_djvu.php

Farm-scale ethanol fuel production plant -- the Gildred/Butterfield Fuel Alcohol Plant, winner of the California Department of Food and Agriculture's Ethanol Fuel Plant Design Competition: Floyd Butterfield's on-farm still operation in full, complete with blueprints. Plant Description, Plant Operating Manual, Plant Performance Data, Plant Construction Guide, Recommendations, Appendixes and eight blueprints of the still, cooker and operating set-up. Operates continuously, 24 hours per day, 10 gallons per hour of 190 proof ethanol. Includes screw press blueprints and construction details. With thanks to Garle A. Webb.

The Butterfield Still -- This report provides details of the design, construction, operation and performance of the FSB Energy Fuel Alcohol Plant.

Mother Earth Alcohol Fuel -- a guide to the fine points of home alcohol production, Mother's Alcohol Fuel Seminar
©The Mother Earth News, 1980 (out of print)
In 1978 The Mother Earth News research team started studying methods and distillation processes, testing mash formulas, designing apparatus, compiling information, converting engines and running seminars, spending upwards of US$300,000 on the project. This manual is the result.
Basic information, methods, different feedstocks, processing, mash recipes, still designs and plans, low-cost backyard stills, Alcohol as an Engine Fuel, How To Adapt Your Automobile Engine For Ethyl Alcohol Use, Do-It-Yourself Water Injection System, MOTHER's Waste Oil Heater, and more.

The Manual for the Home and Farm Production of Alcohol Fuel
by S.W. Mathewson
Ten Speed Press
© Copyright 1980 J.A. Diaz Publications (out of print)
This excellent manual gives you all the information you need to get going with making your own alcohol fuel. Aimed at small-scale production, good chapters on fuel theory, everything about feedstocks, processing, fermentation, yeast, using ethanol, distillation.

The Sunflower Seed Huller and Oil Press -- by Jeff Cox (from Organic Gardening, April 1979, Rodale Press): Vegetable oils used to be one of those items you just HAD to buy. Now here's how to make your own. In 2,500 square feet, a family of four can grow each year enough sunflower seed to produce three gallons of homemade vegetable oil suitable for salads or cooking and 20 pounds of nutritious, dehulled seed -- with enough broken seeds left over to feed a winter's worth of birds.

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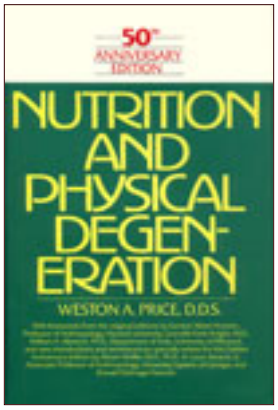
The Darwin of nutrition

"Nutrition and Physical Degeneration" by Weston A. Price, DDS, 1939, 50th anniversary edition 1989, Keats, ISBN 0-87983-502-8



Weston A. Price discovered what health is made of, and proved it. In the early 1930s Price and his wife ("Mrs Price") travelled more than 100,000 miles to study the diets and health of isolated primitive peoples in Africa, South America, Australia, Polynesia, Europe and northern Canada, at a time when such communities still existed.

Price undertook amazing journeys into the wilds to seek out people "who were living in accordance with the tradition of their race and as little affected as might be possible by the influence of the white man".

Weston A. Price

Wherever he found them -- regardless of race, diet and climate -- they were a "picture of superb health": they had superb physiques, perfect teeth, no arthritis, no tuberculosis, no degenerative diseases, and they were cheerful, happy, hardy folk.

That changed radically when he compared them to other, less isolated groups of the same peoples, charting a catastrophic health decline the closer they got to the "trade foods" produced by industrial society (processed foods grown by synthetic farming methods), in the shape of the "white man's store".

He found it takes only *one generation* of eating industrialized food to destroy health and immunity.

Price was a good scientist and a thorough investigator and collected an enormous amount of data with thousands of supporting photographs -- his case simply doesn't leave any room for argument. We are all victims. But he leaves us with the promise of regeneration. Thwarted health can be recaptured.

Price's book makes fascinating reading -- it's a great travelogue, full of interest and charm, and essential to understanding the nature of food and health. Price is truly "the Charles Darwin of nutrition".

Steve Solomon has written an extended review of "Nutrition and Physical Degeneration" (like many, reading it changed his life), including a good selection of photographs from the book, online at the **Soil and Health Library** -- the full text of the book is also online:
http://www.soilandhealth.org/

Preparing the potato beds in Loetschendal Valley high in the Swiss Alps, spring 1987 -- in 1931 Weston Price found a secluded community here of healthy mountaineers who had no doctor and no dentist, and never needed them. (Keith Addison)

For further information see **Sally Fallon's** excellent and informative website at the **Weston A. Price Foundation**:
http://www.westonaprice.org/

Two reviews by **Sally Fallon** -- "Nutrition and Physical Degeneration", with photographs and tables:
http://www.westonaprice.org/nutrition_greats/price.html
Weston A. Price and his work:
http://www.westonaprice.org/book_reviews/nutrition_physical.html

Order **"Nutrition and Physical Degeneration"** from amazon.com, or from the Price-Pottenger Nutrition Foundation:
http://www.price-pottenger.org/

Article on butter by Weston A. Price, **"Are the Activators Revealing The Nature of Life in Health and Disease Including Dental Disease?"**, Cleveland, Ohio 1932:
http://www.westonaprice.org/archive/archive_weston.html

"Acid-Base Balance of Diets Which Produce Immunity to Dental Caries Among the South Sea Islanders and Other Primite Races" by Weston A. Price:
http://www.price-pottenger.org/Articles/Acid_base_bal.htm

Price's **"Letter to his Nieces and Nephews"**:
http://www.price-pottenger.org/Articles/PriceLetter.htm

"The Skinny on Fats" from "Nourishing Traditions: The Cookbook that Challenges Politically Correct Nutrition and the Diet Dictocrats", by Sally Fallon with Mary G. Enig, PhD., 2nd Edition, 1999, New Trends Publishing, Inc., online at the Weston A. Price Foundation:
http://www.westonaprice.org/know_your_fats/skinny.html

"It sounds like you might have been reading 'Nourishing Traditions,' by Sally Fallon, which has been mentioned on this list several times I think. I finally got it from the library a few weeks ago and was dumbfounded at what I read. Being a nutritionist by training, my thinking about fat and cholesterol was turned upside down! It's a good thing I'm retired, or I'd be in trouble with my boss for not touting the company line!" -- From a letter to the Organic Gardening Discussion List, 8 April 2001.

"The Case for Butter" by Trauger Groh:
http://www.price-pottenger.org/Articles/Case_for_butter.html

See also:

The **Medical Testament** published by the 31 doctors of the Cheshire Panel Committee in England on March 22 1939, full text online at the Journey to Forever **Small Farms Library**.

The Saccharine Disease: Conditions caused by the Taking of Refined Carbohydrates, such as Sugar and White Flour by T. L. Cleave, John Wright, 1974, full text online at the Journey to Forever **Small Farms Library**.

"Nutrition and National Health" by Sir Robert McCarrison, Faber and Faber, 1953, full text online at the Soil and Health Library:
http://www.soilandhealth.org/

"The Wheel of Health: A Study of a Very Healthy People" by G.T. Wrench, Daniel, 1938, reprinted 1960, 1990, full text online at the Journey to Forever **Small Farms Library**.

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- Micro Cogeneration: 21st Century Independent Power -- How to Design and Construct Your Own Independent

Food or fuel?
Straight vegetable oil as diesel fuel

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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- Absolute Alcohol Using Glycerine
- Wood Alcohol
- Wood-to-Oil Process
- Liquefaction
- Biochemical Sources of Fuels

Mother Earth Alcohol Fuel -- a guide to the fine points of home alcohol production, Mother's Alcohol Fuel Seminar
©The Mother Earth News, 1980 (out of print)
In 1978 The Mother Earth News research team started studying methods and distillation processes, testing mash formulas, designing apparatus, compiling information, converting engines and running seminars, spending upwards of US$300,000 on the project. This manual is the result.
Basic information, methods, different feedstocks, processing, mash recipes, still designs and plans, low-cost backyard stills, Alcohol as an Engine Fuel, How To Adapt Your Automobile

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Engine For Ethyl Alcohol Use, Do-It-Yourself Water Injection System, MOTHER's Waste Oil Heater, and more.

The Manual for the Home and Farm Production of Alcohol Fuel
by S.W. Mathewson
Ten Speed Press
© Copyright 1980 J.A. Diaz Publications (out of print)
This excellent manual gives you all the information you need to get going with making your own alcohol fuel. Aimed at small-scale production, good chapters on fuel theory, everything about feedstocks, processing, fermentation, yeast, using ethanol, distillation.

Convert Your Car to Alcohol, by Keat B. Drane, 1980 (out of print) -- Detailed instructions on how to run a gasoline car on clean, renewable ethanol fuel. Covers everything you need, from the fuel line to the carburetor to the ignition system, with tips on cold-weather starting. Scanned by Stan Hartley. Full-text online.

The Sunflower Seed Huller and Oil Press -- by Jeff Cox (from Organic Gardening, April 1979, Rodale Press): Vegetable oils used to be one of those items you just HAD to buy. Now here's how to make your own. In 2,500 square feet, a family of four can grow each year enough sunflower seed to produce three gallons of homemade vegetable oil suitable for salads or cooking and 20 pounds of nutritious, dehulled seed -- with enough broken seeds left over to feed a winter's worth of birds.

Fuel From Sawdust -- by Mike Brown (from Acres, USA, 19 June 1983): Conversion of cellulose, such as sawdust, cornstalks, newspaper and other substances, to alcohol -- "a fairly uncomplicated and straightforward process".

The **UC Davis biodiesel study** -- "Chemical and Bioassay Analyses of Diesel and Biodiesel Particulate Matter: Pilot Study -- Final Report" by Norman Y. Kado, Robert A. Okamoto and Paul A. Kuzmicky, Department of Environmental Toxicology, University of California, Davis, California, November 1996. This U.S. Department of Energy study found that the use of pure biodiesel instead of petroleum-based diesel fuel could offer a 93.6% reduction in cancer risks from exhaust emissions exposure. Acrobat file, 3.1Mb.
UC Davis biodiesel study -- summary: the Summary, Results and Discussion sections of the report, in html format.

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Straighter-than-straight vegetable oils as diesel fuels, Michael Allen, Visiting Professor, Prince of Songkla University, Thailand: What happens when you try to run a diesel motor on crude palm oil.

Palm Oil as a Fuel for Agricultural Diesel Engines: Comparative Testing against Diesel Oil, by Gumpon Prateepchaikul and Teerawat Apichato of Prince of Songkla University, Thailand. Comparative tests of indirect injection agricultural engines fueled by diesel and refined palm oil and operating continuously at constant 75% maximum load and speed of 2,200 rpm. SONGKLANAKARIN Journal of Science and Technology Vol.25 No.3 May-June 2003

Review: Utilization of Rapeseed Oil, Rapeseed Oil Methyl Ester or Diesel Fuel -- Exhaust Gas Emissions and Estimation of Environmental Effects, by Jürgen Krahl, Axel Munack, Müfit Bahadir, Leon Schumacher and Nancy Elser, 1996. This report is a review of emissions tests of rapeseed oil and rapeseed methyl esters biodiesel using the US FTP-75 tests or European ECE-15 13 and 5 tests. Emissions are categorized and compared with petroleum diesel fuel in different types of diesel engines. Section 2 on Engine Testing Procedures and section 3, "Environmental Effects of the Main Exhaust Gas Components", are well worth a read in their own right.

The modelling of the biodiesel reaction -- As part of their work to design continuous reactor for the production of palm-oil methyl ester, Michael Allen and Gumpon Prateepchaikul at the Energy Group in the Department of Mechanical Engineering at Prince of Songkla University in Thailand produced a spreadsheet modelling the complex series of reversible reactions which take place during the biodiesel production process. "Rate equations were derived which could be solved by a number of mathematical techniques: In this case, a finite-difference technique was used based on simple spreadsheet functions. The resulting model was compared with results published in the literature as well as with results obtained at the Prince of Songkla University. Applying this model made possible several recommendations to enhance palm-oil methyl ester production in batch reactors..." You can use the spreadsheet to change one parameter in the process and see how it affects the others. This is a combined zip file (480Kb) of the MS Excel spreadsheet (for Windows) and an Acrobat file describing the work. (Make a copy of the spreadsheet and work from that.) See also "Kinetics

of Transesterification of Soybean Oil" and "Kinetics of Palm Oil Transesterification in a Batch Reactor", both below.

Kinetics of Transesterification of Soybean Oil, H. Noureddini and D. Zhu, Journal of the American Oil Chemists' Society, Vol. 74, no. 11 (1997). This study investigates what actually happens during the transesterifcation process to produce biodiesel. The effect of variations in mixing intensity and temperature on the rate of reaction were studied at a constant ratio of alcohol to triglycerol and concentration of catalyst. Acrobat file, 540Kb.

Kinetics of Palm Oil Transesterification in a Batch Reactor, by D. Darnoko and Munir Cheryan, University of Illinois, Department of Food Science and Human Nutrition, Agricultural Bioprocess Laboratory, *Journal of the American Oil Chemists' Society* (JAOCS) Vol. 77, No. 12 (2000) --What happens during the biodiesel process reaction. Acrobat file, 72Kb.

The Butterfield Still -- This report provides details of the design, construction, operation and performance of the FSB Energy Fuel Alcohol Plant.

Farm-scale ethanol fuel production plant -- the Gildred/Butterfield Fuel Alcohol Plant, winner of the California Department of Food and Agriculture's Ethanol Fuel Plant Design Competition: Floyd Butterfield's on-farm still operation in full, complete with blueprints. Plant Description, Plant Operating Manual, Plant Performance Data, Plant Construction Guide, Recommendations, Appendixes and eight blueprints of the still, cooker and operating set-up. Operates continuously, 24 hours per day, 10 gallons per hour of 190 proof ethanol. Includes screw press blueprints and construction details. With thanks to Garle A. Webb.

The Seven Sisters -- The Great Oil Companies and the World They Made, by Anthony Sampson, 1975 (out of print). "The Seven Sisters (from a phrase first popularised by Italian oil tycoon Enrico Mattei): Exxon (Esso), Shell, BP, Gulf, Texaco, Mobil, Socal (Chevron) -- plus an eighth, the Compagnie Francaise Des Pétroles (CFP-Total)." We scanned chapters 8-14 of the book and posted them under the subtitle "OPEC, Big Oil and you" at the **Biofuel mailing list**, where they raised much interest. "I was so interested in the story, I went out and ordered

myself a copy," wrote one list member. "This is great reading, and gives us a small glimpse into the control that big oil has over us. Thanks." Seven chapters full-text online.
See also: **Who gets what from imported oil?** Data from OPEC (Acrobat file, 36kb):
http://www.opec.org/NewsInfo/WhoGetsWhat/2001.pdf

The Fats and Oils: a General View, by Carl L. Alsberg and Alonzo E. Taylor, 1928, Food Research Institute, Stanford University, California
First in a series of five Fats and Oils Studies published in the 1920s by the Food Research Institute. World War 1 had demonstrated the basic importance of the fats and oils for food, feed, and raw material for industry. These publications sought to address a lack of reliable data on which to base policy and business decisions. Good overview of the subject written in layman's terms, covers nature and sources of fats and oils, properties, technology, production, international trade and more. Not that much has changed since then, it's just grown more complex. A clear and informative guide -- useful information for anyone making biodiesel, also much of interest on how agricultural production and the trade in commodities can influence prices and availability of feedstock. Also much of interest for soapmakers. Full text online. See also:

Oils -- King's American Dispensatory, by Harvey Wickes Felter, M.D., and John Uri Lloyd, Phr. M., Ph. D., 1898
http://www.ibiblio.org/herbmed/eclectic/kings/olea.html

Chemical Reactions of Oil, Fat and Fat Based Products
http://alfa.ist.utl.pt/~fidel/creac/reac.html

Food Fats and Oils (1994) -- online book (Acrobat file, 1.3Mb):
http://www.iseo.org/foodfatsoils.pdf

Minor Oil Crops, B.L. Axtell from research by R.M. Fairman, Intermediate Technology Development Group, Rugby, UK, FAO Agricultural Services Bulletin No. 94, Rome, 1992, ISBN 92-5-103128-2: Part I - Edible oils, Part II - Non-edible oils, Part III - Essential oils -- Full text online:
http://www.fao.org/inpho/vlibrary/x0043e/x0043e00.htm

Put a chicken in your tank -- Eccentric British inventor Harold Bate found a way of converting chicken droppings to gas

-- and runs his car on it. He claims chicken power will run a car faster, cleaner, and better than gasoline. Bate says he has driven his 1953 Hillman at speeds up to 75 mph without the use of gasoline.

Methane Digesters For Fuel Gas and Fertilizer, With Complete Instructions For Two Working Models -- by L. John Fry, Santa Barbara, Calif. 93103, © 1973, Eighth Printing (out of print). Excellent manual on making and using methane -- biogas. Fry developed his techniques while running a pig farm in South Africa, designing the first full scale displacement methane plant. Good information on integrating biogas production with gardening and farming, and with pond-culture food production. Designs for a Sump Digester using 55-gal oil drums and an Inner Tube Digester. With thanks to Kirk McLoren.
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Interview: L. John Fry
Interview: Ram Bux Singh

Nepal Biogas Plant -- Construction Manual. Construction Manual for GGC 2047 Model Biogas Plant. With Dutch and German support, Nepal's Biogas Support Programme has built 95,400 biogas plants in 10 years, with potential for half a million more. These are fixed dome biogas plants, designed in Nepal. Sizes are household-scale from 4 to 20 cubic metres. The feedstock is cattle dung and water (but other feedstocks will work just as well). For instance, the 4-cubic-metre plant requires input from 2-3 cattle, the 10-cubic-metre plant needs 6-9 cattle. This manual includes full construction details, plans and data. With thanks to Olivier Morf.

Jean Pain: France's King of Green Gold -- Frenchman Jean Pain built a home-made power plant that supplies 100% of the his energy needs. The core of the system is a 50-ton compost mound, three metres high and six across, made of pulverized tree limbs and underbrush. Buried inside the compost is a 4-cubic-metre sealed steel tank 3/4-full of the same compost,

producing methane -- bio-gas. Tubes connect the tank to a pile of 24 truck-tyre inner tubes, the gas reservoir. Pain uses the gas to cook all the food, fuel a truck and produce electricity, via a methane-fuelled internal combustion engine that turns a generator. The truck runs off two gas bottles on the roof, with a range of 100 km. Another tube runs from a well and into the heap, with 200 metres of tubing wound round the tank, the water emerging at 60 deg C at 4 litres a minute, enough for central heating, the bathroom and the kitchen. The compost heap continues fermenting for nearly 18 months, and then yields 50 tons of natural fertilizer. (With thanks to Ramjee Swaminathan.)

Micro Cogeneration: 21st Century Independent Power -- How to Design and Construct Your Own Independent Power System -- First Edition, 1993, by Kirk McLoren, Independent Power, Billings, Montana. Covers all aspects of this most useful subject, from thinking about it to putting it all together, and everything in between.
This file requires the DjVu plug-in reader, available as a free download (about 1Mb) for Windows, Linux, Solaris and Macintosh. View online or download the file for offline viewing.
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Optimization of a Batch Type Ethyl Ester Process -- recipe for biodiesel from ethanol (which you can make yourself), instead of methanol (which is toxic, fossil-fuel derived, and you can't make it yourself).
See: **Ethyl-esters biodiesel**

Production and Testing of Ethyl and Methyl Esters, University of Idaho, Dec 1994.
See: **Ethyl-esters biodiesel**

Transesterification Process to Manufacture Ethyl Ester of Rape Oil by Roger A. Korus, Dwight S. Hoffman Narendra Barn, Charles L. Peterson, and David C. Drown, Department of Chemical Engineering, University of Idaho, Moscow, Idaho, USA (Acrobat file, 672Kb)
See: **Ethyl-esters biodiesel**

Making and Testing a Biodiesel Fuel Made From Ethanol and Waste French-Fry Oil by Charles L. Peterson,

Daryl Reece, Brian Hammond, Joseph C. Thompson, Sidney Beck, University of Idaho, Idaho, USA (Acrobat file, 2.4Mb)
See: **Ethyl-esters biodiesel**

A complete report covering all of the applications of ethanol in gasoline, in new and used engines: ERDC Project No 2511 **Intensive Field Trial of Ethanol/Petrol Blend in Vehicles**. This trial showed no harm to any engines, and documented the benefits. This is the **Executive Summary**, compliments of Apace Research Ltd -- 10 pages, 32kb Acrobat file.

Wood-Ethanol Report: Technology Review, Environment Canada 1999 -- good overview of the problem of producing ethanol from cellulose and the current solutions on offer.

The **Fuel Injection Equipment (FIE) Manufacturers** (Delphi, Stanadyne, Denso, Bosch) issued a statement on biodiesel. They strongly support it, but they have their concerns too, and they're very involved in standards development. They had a fright in Europe in the early 90s when the introduction of low-sulfur diesel saw widespread damage to injection systems, with excessive wear and failure. The same thing happened in California. They don't want it to happen with biodiesel. This is their statement.
Summary -- html
Full document -- Acrobat file, 104kb

Biodiesel quality testing: Scientists at USDA's Agricultural Research Service have adapted a sophisticated tool known as near-infrared spectroscopy -- NIR -- to help speed the development of biodiesel fuels made with vegetable oils. The standard for measuring biodiesel quality has been a complex analytical method called gas chromatography (GC). But GC is a complex piece of laboratory equipment, requiring technical expertise and at least an hour to perform. It also requires chemical reagents and solvents that need special handling and costly disposal. NIR is a safer and faster way to check the quality of biodiesel fuel, and no special training is needed.

See also: **Quality**

NIR Helps Turn Vegetable Oil into High-Quality Biofuel -- ARS News Release, June 15, 1999

Rapid Monitoring of Transesterification and Assessing Biodiesel Fuel Quality by Near-infrared Spectroscopy Using a Fiber-Optic Probe, by Gerhard Knothe, ARS, JAOCS 76, 795-800 (July 1999)

Monitoring a Progressing Transesterification Reaction by Fiber-Optic Near Infrared Spectroscopy with Correlation to 1H Nuclear Magnetic Resonance Spectroscopy, by Gerhard Knothe, ARS, JAOCS 77, 489-493 (May 2000)

Cornmeal Adsorber for Dehydrating Ethanol Vapors -- by Michael R. Ladisch et al., Laboratory of Renewable Resources Engineering, Purdue University. Ground corn is an effective and energy efficient means to remove water from ethanol. And when its drying capacity is worn out, it can be fermented and distilled to make more ethanol. About half the ethanol now produced in the US is dried using corn grits. This 1981 paper is the original work on the subject.
See: **Anhydrous ethanol**

Separating Ethanol From Water -- by Renaldo V. Jenkins of Langley Research Center, Hampton, Virginia, USA. More economical methods of separating water from ethanol to produce anhydrous ethanol, using sulphur or castor oil. Provided by F. Marc de Piolenc.
See: **Anhydrous ethanol**

Apparatus for the Continuous Manufacture of Absolute Alcohol -- US Patent 1,704,213, E. Ricard, filed January 23, 1924. Scanned by F. Marc de Piolenc.
Acrobat pdf file, 524kb.
In html

Absolute Alcohol Using Glycerine -- Mariller-Granger Processes, from E. Boullanger: Distillerie Agricole et Industrielle (Paris: Ballire, 1924). Mariller's absolute alcohol production process by dehydration using glycerine, various systems examined and explained. Translation from the French by F. Marc de Piolenc.
See: **Anhydrous ethanol**

Wood Alcohol -- from E. Boullanger: Distillerie Agricole et Industrielle (Paris: Ballire, 1924). An examination of the

technology of producing ethanol from wood, going back to 1819. This survey covers the field excepting for the new enzymes, which still haven't arrived after 20 years of promises. Translation from the French by F. Marc de Piolenc.

Wood-to-Oil Process -- by S. Friedman, A.S. Mehta and P.L. Thigpen, from Considine, Douglas M. (Ed-in-Ch): Energy Technology Handbook (McGraw-Hill, 1977). Scientists at the Pittsburgh Energy Research Center of the Bureau of Mines, U.S. Department of the Interior, converted wood wastes, cowdung and garbage into oil in the laboratory. Any cellulosic material can be converted to oil by this process. Economics, Process, Drying and Grinding, Feed Systems, Wood-Oil Slurry Feed System, Solids Feed System, Pretreated Wood-Oil Slurry System, Reaction, Reactor Off-Gases, Oil Recovery, Environmental Considerations. Scanned by F. Marc de Piolenc.

Liquefaction -- Chapter 3, *Energy Applications of Biomass*, Michael Z. Lowenstein (Ed). (Elsevier Applied Science Publishers, 1985). Natural processes that produce liquids suitable as fuels are performed by certain tree species (e.g., the Brazilian *Copaifera langsdorfii* tree that yields sesquiterpenes that can be used as diesel fuels without modification, and plants that bear oil seeds; e.g., sunflowers). An approach to the natural production of liquid fuels by biomass is under investigation by Nobel prize winner Melvin Calvin using a combination of natural photosynthesis and genetic manipulation. The overall process consists of three steps: hybridization of Euphorbia lathyris with E. esula,which produces fewer hydrocarbons than E. lathyris but grows as a perennial rather than an annual; modification of the photosynthetic pathway of the hybrid to cyclize C 15 intermediates so that sesquiterpenes are formed; and transfer of the gene that codes for sesquiterpene production from *C. langsdorfii* to the plant. Scanned by F. Marc de Piolenc

Biochemical Sources of Fuels -- by John D. Keenan, Assistant Professor of Civil and Urban Engineering, University of Pennsylvania, Philadelphia, Pa. From Considine, Douglas M. (Ed-in-Ch) : Energy Technology Handbook (McGraw-Hill, 1977). Survey of biofuels potential -- Photosynthesis, Photosynthetic Hydrogen, Biochemical Oxidations, Ethanol Fermentation, Butanol-isopropanol Fermentation, Methane Fermentation, Hydrogen Fermentation, Cellulose Degradation, Biochemical Fuel Cells, Extraction of Shale Oil, Conversion Economics, with extensive references. Scanned by F. Marc de Piolenc.

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Temperature gauges
Automatic temperature control valves
Rustproofing, anti-corrosion
General equipment
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Soldering, brazing

Biodiesel suppliers

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Ag Environmental Products -- Lenexa, KS, Phone: (800) 599-9209, Contact: Doug Pickering, e-mail: Dpickering@agp.com
http://www.soygold.com

Aiko Associates -- Biodiesel -- truckload or railcar quantities to the continental USA, email aiko@aiko.org, Order s 1-727-725-8437
http://aiko.org/

Biodiesel Industries (prev. Biodiesel Development Corporation) -- Marathon, FL, Phone: (877) BIO-FUEL (877) 246-3835, Contact: Russ Teall, e-mail: Rteall@aol.com
http://www.pipeline.to/biodiesel/

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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Internet interaction
Finding your way

Columbus Foods -- Chicago, IL. Soy methyl esters are available in 2.5 gallon bottles, 6.5 gallon pails, 55-gallon drums, or bulk tank truck delivery. Call Joe Loveshe at (800) 322-6457, email jloveshe@columbusfoods.com
http://www.columbusfoods.com/vegetableoils/soy_methyl_esters_main.html

Griffin Industries -- Cold Spring, KY, Phone: (800) 743-7413, Hart Moore, email jhmoore@griffinind.com
http://www.griffinind.com

Hiperfuels -- Buy biodiesel, methanol, E85 gasohol and other fuels, additives, etc online, 5-gallon containers, delivery by UPS/Fedex. Houston, Texas, USA. Phone 713 305-3133, Contact Jess Hewitt, jhewitt@ix.netcom.com
http://www.hiperfuels.com
http://www.buybiodiesel.com/

NOPEC Corporation -- Now OceanAir Environmental Fuels (see **Biodiesel Technology**, below). For suppliers, see World Energy Alternatives, below. Contact Jim Davis, Wes Berry or Mahesh Talwar, sales@oceanairenvironmental.com, oceanair1@att.net
http://www.oceanairenvironmental.com/

Pacific Biodiesel -- 285 Hukilike Street, B103, Kahului, Hawaii 96732, Telephone: (808) 877-3144, Fax: (808) 871-5631, info@biodiesel.com, Contact Bob King, President bking@biodiesel.com
http://www.biodiesel.com

Peter Cremer North America, L.P. -- Cincinnati, OH, Phone: (513) 471-7200, Contact: H.M. Findley, e-mail: Hfindley3d@aol.com

Southern States Power Company -- 4505 Allstate Drive, Suite 108, Riverside, CA 92501. (909) 367-2463 Office (909) 367-2469 Fax. E-mail: SSPOWERCO@AOL.COM
http://www.SSPOWERCO.NET/

Ward Oil Company, Inc., Tampa, Florida, supplies Bio Diesel to the Central Florida area and beyond. Contact: Aaron Evenson aka "Bio-Man", email: wardoil1@juno.com
Phone: 1-800-232-5591
Fax 1-813-238-7066

West Central Cooperative -- Ralston, IA, Phone: (712) 667-3200, Contact: Bev Tierney, e-mail: bevt@westcentral.net, Gary Haer (913) 884-8521, e-mail: haer@qni.com
http://www.soypower.net

World Energy Alternatives -- Now the biggest supplier in the US, virgin and recycled oil, distributor for OceanAir Environmental Fuels (NOPEC Corporation). Headquarters: Chelsea, MA, Phone: (617) 889-7300; Western U.S.: Half Moon Bay, CA, Phone: (650) 712-9688, Contact: Gene Gebolys, email: Geneg@worldenergy.net

Schools projects
Introduction
Biofuels
Solar box cookers
Backpack stove
PicoTurbine
Low-tech radio
What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox
School gardens
School composting
Trees and forests
The Beach House fish pond
HOMeR
Eco-footprint
School and youth programs on the Web
Education resources on the Web
Children's poetry

Contact us

To Keith Addison
keith@journeytoforever.org
To Midori Hiraga
midori@journeytoforever.org
Homepage
http://journeytoforever.org/

Handmade Projects
Ichijima
Japan

http://www.worldenergy.net

UK

Allied Biodiesel Industries (UK) -- Representing the British Biodiesel Industry, links to UK suppliers, by region.
http://www.biofuels.fsnet.co.uk/biobiz.htm

Ebony Solutions UK, makers of "e-diesel" biodiesel. Collection or delivery - e-diesel is supplied in bulk by tanker or in 1000 litre pallet tanks (picture) which can be collected or delivered, minimum order 1000 litres, anywhere in mainland UK. Northwich, Cheshire, England. CW8 2SX Tel +44 (0)1606 301 222 Fax +44 (0)1606 301 320
E-mail:
ediesel@ebony-solutions.co.uk
http://www.ebony-solutions.co.uk/
Buy fuel:
http://www.ebony-solutions.co.uk/buy_ed.htm

Envirodiesel Ltd. -- manufactures biodiesel from used cooking oils at a new facility near Doncaster, UK, 1,000 litre IBCs or 25 litre drums. Email:
info@envirodiesel.co.uk
Envirodiesel Ltd.
Unit 13A Provincial Park
Nether Lane
Ecclesfield
Sheffield
S35 9ZX
http://www.envirodiesel.co.uk/

Australia

Biodiesel in Australia -- Join the **Biodiesel Association of Australia** and automatically become a member of our co-op allowing access to ready made Biodiesel from a filling station. Adrian Lake, aplake@vtrekker.com, Phone: (02) 9526 1442, Mobile: (04) 1188 9971, Paul Martin, Phone: (02) 9521 4372, Mobile: (04) 1537 7060
http://www.biodiesel.org.au/

Canola-based B100 biodiesel is now being retailed at **SAFF** Head Office service station, Pooraka (northern suburbs of Adelaide, South Australia). Biodiesel is selling at the pump for 85.9 cents per litre. SAFF (South Australian Farmers Fuel) is a fully-independent, South Australian-owned fuel wholesale/retail network with over 40 branded service station retail outlets. SAFF is committed to biofuels, and is also retailing E20 (20% ethanol in unleaded petrol) at all its sites. Currently biodiesel is only available at the Head Office site, which is located at 13 Merchant Crescent, Pooraka (adjacent to the Pooraka Markets). Phone Mike Jureidini (08) 8262 3002 or email biofuel@farmersfuel.com.au for further details.

France

Eridania Beghin Say-Novaol -- Cereol division makes biodiesel. N°1 in Europe for olive oil, sunflower oil, rapeseed oil. 14, Bd du Général Leclerc F-92572 Neuilly-sur-Seine cedex (France).
http://www.eridania-beghin-say.com/
World addresses:
http://www.eridania-beghin-say.com/html/gb/groupe/map4.htm

Novaol France. Bertrand Dufrenoy -- 14, Bd Du Général Leclerc, 92572 Neuilly-Sur-Seine Cedex (France). Tel: 0033 1 41 43 17 37 Fax: 0033 1 41 43 17 72 Email: bdufrenoy@fr.ebsworld.com

Germany

Oelmühle Leer Connemann GmbH & Co. -- Sägemühlenstraße 45, D-26789 Leer(Ostfriesl),Germany, Telefon: +49-(0)491-8002-116, Fax: +49-(0)491-8002-140, eMail info@oelmuehle.de
http://www.biodiesel.de/

Italy

agroindustria Compart (Italy)
http://www.pandd.it/compart/agroin.htm

Distilleria F. Palma s.p.a. Gruppo Palma -- Establecimiento: via G. Marconi 27, 80029 SANT'ANTIMO (NA) Tel.(081) 8332735-8332830, fax(081) 5051562

Mariani Petroli (Italy)-- BIOFOX biodiesel. Email: info@biofox.com
http://www.marianipetroli.com/2.htm

Novaol srl -- Via Madre Cabrini 10 - I - 20122 Milano (Italy). tel. +39-2-5821051 - fax +39-2-58210574
http://www.novaol.it/

Oleifici italiani, SpA (Italy) -- Sede Sociale: 72017 Ostuni (BR), Via Nino Sansone 49 - C.p. 28 Amministrazione e Stabilimento: 70043 Monopoli (BA), S.S. 16 km 841,700 - C.p. 167 Tel. 0039 + 80 + 9306565 - Fax. 0039 + 80 + 808108
http://wwwba.clio.it/aiia/bartolin.htm

Biodiesel technology

ENERGEA -- The next generation of biodiesel technology -- CTER "Continuous Trans Esterification Reactor" technology opens a new chapter in biodiesel production: up to 50% lower cost of investment, turn-key modules the size of a container, multi-feed-stock technology, production capacity 5000 to 100,000 mt/a or more, high quality fuel according to DIN 51 606, future CEN-standard. Email: mail@energea.at
http://www.energea.at/

Biofuel Systems provides state-of-the-art biodiesel process equipment which meets all recognised international safety standards (eg. ATEX) and will produce biodiesel from a range of feedstocks to meet recognised standards, including

ASTM 6751-03, EN 14214:2003, DIN V 51606. Currently offers systems from 900 litres per week upwards. Available in Europe through Eurobiodiesel Ltd (http://www.eurobiodiesel.com), in Australasia through New Zealand Biofuels Limited, and in the rest of world direct from Biofuel Systems, 58 Church Street, Ormskirk, Lancashire, ENGLAND L39 3AW. Fax: +44 1695 571222 e-mail: info@biofuelsystems.com
http://biofuelsystems.com

Biodiesel Technologies, Vienna -- Compact biodiesel manufacturing plants installed in a 20-ft container frame, ready to operate, multi feedstock re-esterification, final conditioning of biodiesel. Optional module: feedstock oil purifier, dryer. Production capacity 500 to 1,000 liters per hour of biodiesel (depending on model).

500 liters per hour capacity unit

Member of the Biodiesel Austria Group. Contact Dr. L. Kondor, Managing Director, Tel: + 43 1 877 0553, Fax: + 43 1 877 8446, E-Mail: dr-kondor@eunet.at
http://www.biodieselaustria.com

NOPEC Corporation (OceanAir Environmental Fuels) -- Lakeland, Florida plant is a "world showcase of the latest processing technology", with a 10 million gallon/year capacity. Provides contract manufacturing services and biodiesel production technology. Flexible, multi-feed-stock technology. Phone (863) 683-7199, fax (863) 683-1058, email Jim Davis, Wes Berry or Mahesh Talwar, sales@oceanairenvironmental.com, oceanair1@att.net
http://www.oceanairenvironmental.com/

Pacific Biodiesel -- Plant installation -- two configurations: 200,000 gallons/year (750,000 liters/year), expandable in 200,000 gallons/year increments to maximum 800,000 gallons/year (3,000,000 liters/year); or 400,000 gallons/year (1,500,000 liters/year) expandable in 400,000 gallons/year increments to maximum 1,600,000 gallons/year (6,000,000 liters/year). Telephone: (808) 877-3144, Fax: (808) 871-5631, info@biodiesel.com, Contact Bob King, President bking@biodiesel.com
http://www.biodiesel.com

BioDiesel International of Austria uses re-esterification in its multi-feedstock production system to handle fresh plant oils and/or waste cooking oils and/or animal fats and/or animal fats and fatty acids (as much as 20%), with no loss of free fatty acids, 0% wastes, 0% waste water and no disposal costs, resulting in pure biodiesel plus glycerine (for use in the chemical and pharmaceutical industries) plus a solid fertilizer for agricultural use (potassium phosphate). Yield is 100%: 1 kg of raw material makes 1 kg of high-quality biodiesel.
http://www.biodiesel-intl.com

Superior Process Technologies, USA -- Multi-feedstock biodiesel processing technology, turn-key engineering and design services. "Superior's biodiesel technology offers the highest efficiency and is scalable from the largest continuous processing facilities in the world to small-scale alternative feedstock facilities." Contact: sales@SuperiorProcessTech.com

http://www.SuperiorProcessTech.com

Crown Iron Works Company, USA -- Enhanced continuous and batch methyl ester production processes: continuous process is a two-stage reaction system followed by ester washing, drying and methanol recovery; batch process is designed for smaller scale and/or multi-feedstock capability, several reactor options. Glycerine recovery equipment capable of producing 99.7% USP glycerine. Technology and design assistance to enhance existing ester plants. P.O. Box 1364, Minneapolis, MN 55440-1364 USA. Tel: 1/651/639-8900, Fax: 1/651/639-8051, Email: sales@crowniron.com. Also in Europe, Australia, Honduras, China.
http://www.crowniron.com/index.html

The **Austrian Biofuels Institute** -- an international centre of competence for liquid biofuels: Production: feasibility studies, process technologies for biofuels, project management; Feedstock supply: oilseed plant production and breedin, oil-mill technologies, waste oil recycling, logistic systems for waste oil collection. All countries of the European Union and supports biofuels business projects worldwide.
http://www.biodiesel.at/index2.html

Standard testing

Biodiesel fuel testing for the US ASTM D-6751 standard:

Analytical Testing Services, Inc.
http://wetestit.com/

Harris Testing Laboratories, Inc.
http://www.harristestinglab.com/quote/d6751.htm

Glycerine purification

Solvent purification distillers by **Recycling Sciences, Inc**. Set the temperature and leave it alone. It'll purify the glycerine, at a price. They offer a special unit for biodiesel makers, price US$31,000 for a unit that will do 100 gallons an hour of any solvent recycling -- methanol/ethanol recovery from a biodiesel/glycerine solution before separation, pure glycerine from the crude process by-product, etc, in a very safe manner. Second-hand units can be found for as little as $5,000, but make sure it's the biodiesel model (much quicker). (Information from David Hollenback at the University of Idaho and Steve Woolcott, HarvestEnergy, Sydney, Australia)
http://www.rescience.com

Crown Iron Works Company, USA -- Glycerine recovery equipment capable of producing 99.7% USP glycerine. P.O. Box 1364, Minneapolis, MN 55440-1364 USA. Tel: 1/651/639-8900, Fax: 1/651/639-8051, Email: sales@crowniron.com. Also in Europe, Australia, Honduras, China.
http://www.crowniron.com/index.html

See **Glycerine**

Gas Chromatographs (GC)

SRI Instruments supplies Low Cost Gas Chromatographs, used for biodiesel quality testing. Also sells pre-owned equipment. 20720 Earl Street Torrance, Calif. 90503 U.S.A. Telephone: (310) 214-5092 Fax: (310) 214-5097. (Information from Steve Woolcott, HarvestEnergy, Sydney, Australia)
http://www.srigc.com/

Near Infrared Spectroscopy (NIR)

For Biodiesel quality testing
See: **NIR Helps Turn Vegetable Oil into High-Quality Biofuel**

Dr Gerhard Knothe, of ARS, USDA, is willing to help users implement NIR testing for biodiesel. E-mail: knothegh@mail.ncaur.usda.gov

NIR equipment suppliers

(Information from Steve Woolcott, HarvestEnergy, Sydney, Australia, and Steve Spence of WebConX)

Foss NIRSystems
http://www.foss-nirsystems.com/

Thermo Electron
http://www.thermo.com/

Bruker Optics
http://www.bruker.com/optics/pages/products/nir/matrix.htm

ISOChem Near Infrared Analyzer from LT Industries
http://www.ltindustries.com/prod01.htm

Grating Spectrophotometer, absorption photometer
http://www.topac.com/spectrophotometer.html

Grabner Instruments: IROX Diesel -- Diesel Analysis with FTIR Technology
http://www.grabner-instruments.com/index.html

Oilseed presses

The Sunflower Seed Huller and Oil Press -- by Jeff Cox (from Organic Gardening, April 1979, Rodale Press): Vegetable oils used to be one of those items you just HAD to buy. Now here's how to make your own. In 2,500 square feet, a family of four can grow each year enough sunflower seed to produce three gallons of homemade vegetable oil suitable for salads or cooking and 20 pounds of nutritious, dehulled seed -- with enough broken seeds left over to feed a winter's worth of birds. Online at the Journey to Forever **Biofuels Library**.

ApproTec's Mafuti Mali ("Oil Wealth") press is a manual press for small-scale local production. The Hela Mk II is a high-performance manual press for extracting cold-pressed oil from sunflower and other seeds. The extraction efficiency is considered better than any other manual press -- about 12 kg of sunflower seed per hour. Easy to use, tough and durable, but not cheap -- US$265 in Tanzania. Contact Hugh C. Allen, cd@approtec.or.tz
http://www.approtec.org/tech_oil.shtml

Hela Mk II

The **Sundhara** oil expeller, designed in Germany for use in Nepal, now made in Nepal and Zimbabwe -- 60-70kg/hr (about 15 litres of oil). At the Jatropha Website:
http://www.jatropha.org/expellers/sundhara-1.htm

The **Jatropha System** -- many oilseed presses detailed here, see "Oil extraction":
http://www.jatropha.org/

Small-scale electric screw presses to press oil from seeds from **Täbypressen** in Sweden.
http://www.oilpress.com

KOMET Vegetable Oil Expeller, IBG Monforts in Germany -- range covers small hand-operated as well as powered machines. Virtually all oil-bearing seeds, nuts, and kernels can be pressed with the standard equipment without cumbersome adjusting of screws and oil outlet holes. The vegetable oil produced generally needs no refining, bleaching, or deodorizing. Big nuts, kernels, and copra (dried coconut meat) have to be crushed to the particle size of peas on the KOMET Cutting Machine "System CRUSHER". IBG Monforts:
http://www.oekotec.ibg-monforts.de/
Neoteric Biofuels Inc. in British Columbia, Canada:
http://www.biofuels.ca/

India's **United Oil Mill Machinery & Spares Pvt. Ltd** manufactures and exports an entire range of machinery and equipment for small, medium and large capacity oil mills for seed preparation, oil expelling, filtration and refining. Oil expellers for extraction of oil from any oil-bearing seed, capacities from 1 ton to 150 tons per day (24 hours); other machinery/equipment with matching capacities.

- Tiger Mk I Oil Expeller, all steel construction, fitted with steel gears and pinions, fitted with steam heating kettle with electricals, capacity 2 tons per day (24 hours). US$7,500-00
- Tiger Mk II Oil Expeller, all steel construction, fitted with steel gears and pinions, fitted with steam heating kettle with electricals, capacity 3-4 tons

per day (24 hours). US$9,500-00

- Exceoil Mk 2 Automatic Oil Expeller, all steel construction with double reduction helical gear box with steam kettle complete with electricals, capacity 8-10 tons per day (24 hours). US$15,000-00

Prices F.O.B. Indian port. Also manufactures the Wolf baby oil expeller with a capacity of 1 ton per day , caste-iron construction. Email: umas@vsnl.com
http://www.umas-india.com

Dong Kwang Oil Machine Co., South Korea -- automatic edible oil presses, from 10kg/hr up. For sesame seed, sunflower, palm kernel, cacao, coconut (copra), olive, castor, cotton seed, maize (germ), rice bran, almond (germ), apricot (germ), soya bean, Chinese tung (germ), walnut, peanut, linseed, rape seed, perilla seed, mustard, etc.
http://www.dongkwang.co.kr/en_menu/main.html

Tinytech Plants -- Tiny Oil Mill, oil expeller with cooking kettle, Groundnut Decorticator, Sunflower Cracker or Palm Nut Cracker, Copra Cutter, made in Rajkot, India. Contact: E-mail: tinytech@tinytechindia.com
http://www.tinytechindia.com/oil.htm

Build your own press: "Now Build This -- The Sunflower Seed Huller And Oil Press" -- a small press you can build yourself, powered by a hydraulic bottlejack (and your arm): three gallons of oil from a couple of thousand square feet of plants.
http://ww2.green-trust.org:8383/2000/biofuel/sunfloweroil.htm

"Small-scale Oilseed Processing" by Janet Bachmann, NCAT Agriculture Specialist, Appropriate Technology Transfer for Rural Areas (ATTRA) -- Basic processes involved in small-scale oilseed processing, includes a low-tech method for raw material preparation using sunflower seeds as an example; information on methods and equipment used for oil extraction; notes on clarification, packaging, and storage. Sources for additional information and a list of suitable raw material. Also includes two informative articles from VITA (Volunteers in Technical Assistance), "Understanding Pressure Extraction of Vegetable Oils" and "Understanding Solvent Extraction of Vegetable Oils".
http://www.attra.org/attra-pub/oilseed.html
PDF version (426 kb):
http://attra.ncat.org/attra-pub/PDF/oilseed.pdf

"The Manual Screw Press for Small-Scale Oil Extraction" by Kathryn H. Potts, Keith MacHell, 1993, Intermediate Technology, ISBN 1853391980
Manual oil extraction from peanuts or other soft oilseeds can be a viable enterprise for small businesses. Describes small-scale processes of oil extraction for use in rural areas, as well as ways to market and distribute the oilcake. From IT Publishing:
http://www.developmentbookshop.com/book.phtml?isbn=1853391980

Equipment For Decentralised Cold Pressing of Oil Seeds -- the Folkecenter for Renewable Energy, Denmark -- 64-page report, detailed descriptions and diagrams, mostly mid-range presses from 80kg/hr and up.

http://www.folkecenter.dk/plant-oil/publications/efdcpos_html/index.html
PDF -- Acrobat file, 917k
http://www.folkecenter.dk/plant-oil/efdcpos_ef.pdf

Yields: Typical oil extraction from 100 kg. of oil seeds:
Castor Seed 36 kg
Copra 62 kg
Cotton Seed 13 kg
Groundnut Kernel 42 kg
Mustard 35 kg
Palm Kernal 36 kg
Palm Fruit 20 kg
Rapeseed 37 kg
Sesame 50 kg
Soyabean 14 kg
Sunflower 32 kg

Methanol suppliers

Dyce Chemical Inc. -- 1353 Taylor Pl., Billings MT, USA (406) 248-3131 -- 99+% methanol available in 55-gallon drums only. Call center (Pennsylvania) 888-926-4151. Sales (Montreal) 514-636-9230.

VP Racing Fuels sells pure methanol and has a world-wide distribution network.
http://www.vpfuels.com/

Hiperfuels -- Methanol, 5-gallon containers, buy online, delivery by UPS/Fedex. Houston, Texas, USA. Phone 713 305-3133, Contact Jess Hewitt, jhewitt@ix.netcom.com
http://www.hiperfuels.com
http://www.buybiodiesel.com/

Methanex -- one of the largest suppliers in the world. Sales inquiries sales@methanex.com. Phone (800) 661-8851 (toll free in North America), (604) 661-2600 Fax (604) 661-2676. Mail 1800 Waterfront Centre, 200 Burrard Street, Vancouver, BC, V6C 3M1, CANADA.
http://www.methanex.com/
Current Methanol Prices Worldwide
http://www.methanex.com/methanol/currentprice.htm
Please note:
Methanex has filed a NAFTA case for US $1 billion over California's decision to phase out the noxious gasoline additive MTBE. "Methanex company is attempting to hold taxpayers hostage to the tune of nearly $1 billion, or 1.2 percent of our state budget, because we had the nerve to ban a product that was contaminating water supplies all over the state" -- Earthjustice. See "Challenge of California MTBE Ban Shows How NAFTA Grants Foreign Corporations Greater Rights Than Local Communities and Businesses":
http://www.earthjustice.org/urgent/display.html?ID=58
See also: **MTBE**

Dehydrating ethanol

To dehydrate ethanol to make ethyl esters biodiesel, use Type 3A Molecular Sieve, 4-8 mesh, which absorbs about 20% of its weight of water in a few hours. Take a liter of 95% ethanol, throw in 250g of the zeolite, swirl occasionally, filter out the next day through a strainer. US$2.05 a pound in 10 lb quantities, and reusable indefinitely. Drive off the water under a broiler for an hour. From **Adcoa**, 1269 Eagle Vista Drive, Los Angeles, CA 90041. In California: (310) 532-6086. Outside California: Toll Free 800-228-4124. Fax (310) 532-5404. (Information provided by Ken Provost.)
http://www.thomasregister.com/olc/adcoa/molecula.htm

See **Anhydrous ethanol**

pH testing

Very cheap testers can be a false economy. Good instruments are available for a reasonable price. It's worthwhile to spend a bit extra and get one with a replaceable electrode.

Waterproof pHTestr 30 is a highly accurate pH meter that floats (from Oakton Instruments)

Testing oil -- There are special pH meters made for testing fossil oil products, and they're very expensive. You don't need them for making biodiesel -- all regular pH meters work in natural oils! Measurement takes about 30 seconds in water and up to two minutes in oils. After measuring oils wash the electrode carefully with dishwashing soap and rinse thoroughly, first with tap water and finally with a little distilled water. Never use solvents to clean an epoxy electrode -- solvents are only needed if you sample mineral oil products.

OAKTON Instruments -- pH meters, thermometers and other equipment: "best quality waterproof instruments, many for under US$100, available from stock from a wide variety of distributors". Contact Dominic O'Donnell, e-mail: dodonnell@4oakton.com
http://www.4oakton.com

Eutech Instruments -- pHTestr10, 20 and 30, with user-replaceable electrodes, waterproof, accurate, multipoint 3-point calibration, Automatic Temperature Compensation -- the "Next Wave" of pocket-sized pH testers.
http://www.eutechinst.com/products/testers/intro_pocket_testers.htm
Technical Tips on pH -- useful how-to's on pH and pH measurement:
http://www.eutechinst.com/tech-tips.htm
JAPAN: As One Corporation. Tel: (06) 6447 8631, Ms. Nishiyama, Email: H-NISHIYAMA@so.as-1.co.jp

Davis Instruments -- pH Checker with Epoxy Electrode & Batteries, US$ 34.50 -- Accuracy: Better than 0.2pH. Wide Range: 0 to 14pH with 0.01 reading. Long battery life (3000 hrs).

http://www.davisontheweb.com/shop/page153.html

Fisher Scientific -- Corning Chekmite handheld electronic pH Testers - Follow the path: Catalogs > Fisher Catalog > pH/pX > Meters > Corning > Corning Chekmite* pH Testers
http://www.fishersci.com/

Hagen -- Hagen Wide-Range pH Test Kit, measures pH 4.5-9.0, enough for 100 tests (a user has found you can use half the sample size -- 2.5 ml instead of 5 ml -- and half the number of drops of reagent -- 2 instead of 4 -- to halve the cost)
http://www.hagen.com/hagen/canada/english/aquatic/product.cfm?CAT=1&SUBCAT=124&PROD_ID=01078150010101

Hanna Instruments, Inc. -- pHep® simple, inexpensive pocket pH meters, three models, US$33.60 to $39.50, range 0.0 to 14.0 pH, resolution 0.1 pH, accuracy ±0.2 pH to ±0.1 pH. Website has worldwide branch contact details.
http://www.hannainst.com/products/testers/phtstfmy.htm

Omega Engineering -- PHH-7X pH Tester with replaceable electrode, 0.01 pH resolution, 3000- hour battery life, $35.00. Also sells 4.01, 7.01 and 10.01 buffer sollution (calibration fluid), $5 each, a must for brand-new pH testing units.
http://www.omega.com/

Natural test papers -- Cabbage Paper is made of red cabbage leaves -- alkalis change it to green, acids to red. Here's how to make it, and many others.

Other pH testing methods are phenolphthalein solution from a chemical supplies company -- not "phenol red" -- and pH test papers, which come in various ranges.

Washing

High-quality **bubble stones** for biodiesel washing -- instead of plastic these are sintered bronze and won't be affected by alcohol. Listed as sintered bronze muffler filters 40 micron. Sized from 1/8 to 3/4" pipe size fitting, $1.62 to $5.24 US plus S&H. MSC Industrial Supply Co. Phone 1 800 645 7270. Email cust_service@mscdirect.com or producttech@mscdirect.com for technical enquiries. (Found by Gene Hoxie, Sheridan Wy.)
http://www.MSCdirect.com/

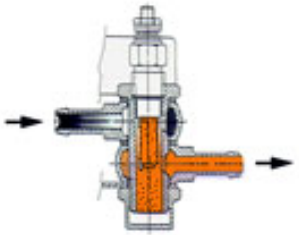
Try pneumatic exhaust silencers, used to quiet exhaust air from air tools or other air / pneumatic systems. They don't rot, they're cheap and they work very well.

See **Bubble washing**

Fuel heaters, filters

VEG-Therm 12 volt self-regulating fuel heater, no external thermostat needed, single unit for smaller engines, double unit for V8s. Also 12 volt filter heater

-- installs in minutes, fits most common filters -- 110V heater with cord and plug for use as tank or oilpan heater. From Neoteric Biofuels Inc. Email: info@biofuels.ca
http://www.biofuels.ca



Diesel-Therm "prevents the filter's pores from clogging up at very low temperatures by warming the fuel with a small heating system, which is mounted in front of the filter. In a matter of seconds, the energy-rich paraffin crystals will dissolve and the fuel passes through the filter as if it were summer." Prices and Order online:
http://www.diesel-therm.com/order.htm

Racor Diesel Fuel Heaters -- from Parker Hannifin Corp.'s Racor Division -- Heavy-duty In-Fuel-Line Diesel Heater comes installed inside a new fuel line and literally replaces the fuel line between tank and primary filter. It prevents power loss and stalls, and assists starting down to -40°F. This heated path is recommended for extended use in cold weather environments and severe conditions.
http://www.parker.com/racor/dfh_intro.html
-- from Mid-Atlantic Engine Supply Corp, Cinnaminson, New Jersey.
http://www.maesco.com/products/racor/r_dfh_intro/r_dfh_intro.html

Racor filters -- from Racor Division (Parker Online Catalog)
http://www.parker.com/parkersql/default.asp?type=2&id=27
-- from J & H Diesel Service, Inc., Greenville, Mississippi USA
http://www.jhdiesel.com/Racor.htm

Vegetable oil filters

Vegetable oil filter cones are made of "Pelon", a generic term which can be cotton fiber but is more often synthetic, the longer-lived usually being synthetic. It can include adhesive versions of both ("fusible pelon"). Both cotton and synthetic Pelon run between 1.5 and 1.75 ounce for filters. Standard Pelon is usually 1.25 ounce. The thicker Pelons can be found in any upholstery supply warehouse in 48" or 96" bolts. -- Todd Swearingen, Appal Energy.

Viscosity meter

Some people use viscosity measures to check the "quality" of their biodiesel. Unfortunately, it won't tell you that, excepting in a laboratory with highly accurate equipment, and even then it would be only a part-indication. Impurities such as mono- and di-glycerides have viscosity values close to those of biodiesel, and the small quantities that make all the difference between poor and good conversion can't be measured this way at the homebrew-level. Viscosity can be a useful comparative indicator, especially when doing test batches. See Viscosity testing.

The **Marsh Funnel Viscometer** is a simple device for indicating viscosity on a routine basis. When used with a measuring cup, the funnel gives an empirical value for the consistency of a fluid. From Fann Instrument Company, Part No. 20100. (With thanks to Huseyin Turcan.)
http://www.fann.com/product_overview1.asp?iprod=20100&catid=4

Visgage® Pocket Viscosity Comparator oil viscosity testing instrument -- the VISGAGE checks oil viscosity on-site quickly and conveniently, without thermometers or stop watches. It can be used to check any oil from light spindle oil to heavy gear oils. Simple to operate, accuracy of 95% or better.Made by Louis C. Eitzen Company, Inc. , email: sales@Visgage.com
http://www.visgage.com/pocket.html

Refractometers

Atago refractometers. With Auto Temp Compensation: ATC-1E: Y20,000; ATC-2E: Y21,000. Manual adjustment: Model N-1E, Y14,000; N-2E Y15,000. Heat resistant: H-50 and H-80, both Y25,000. 32-10 Honcho, Itabashi-ku, Tokyo 173-0001, Japan. Phone 81-3-3964-6131, Fax 81-3-3964-6137, E-mail: export@atago.net
http://www.atago.net/product/hand/hand1.html#1

Sugar Refractometers from **Cole-Parmer**:
http://www.coleparmer.com/catalog/product_list.asp?cls=5119&par=5116,5118&cat=14&sch=318&sku=&sel=

Brewing equipment

Tony Ackland explains what you need at the **Home Distillation of Alcohol** (Homemade Alcohol) site -- thermometers, hydrometers, fermenters, etc.
http://homedistiller.org/equipment.htm

The Revenoor Co. -- Stills ranging from 5 gallons to 1,000 gallons, and an interesting, 3,500-word introductory article on producing alcohol as a fuel from veteran distiller Terry Wilhelm.
http://revenoor.com/

New Zealand commercial suppliers **Spirits Unlimited**, mail order:
http://www.spiritsunlimited.co.nz/

Ray Toms' **Moonshine Supplies** -- Ray "in his own humble opinion is the best person to help you with any brewing problems you may come across". Mail order New Zealand and world-wide (local law is your problem). Hydrometers, Hyper

Yeast, Turbo Yeast, other yeasts, and much more:
http://moonshine.co.nz/spirit.html

Gert Strand AB -- Distillers Yeast, including Turbo Yeast 20%, plus useful turbo yeast FAQ. Order Online (freight takes two weeks, from Sweden). E-mail: strand@partyman.se
http://www.turbo-yeast.com/distillersyeast.html
Brewhaus Inc. -- Gert Strand AB's distributor in North America. E-mail: info@brewhaus.com
http://www.brewhaus.com

The Brewery's Technical Library for articles on brewing related topics -- see Yeasts.
http://www.brewery.org/brewery/Library.html

Temperature gauges

Ashcroft Bimetal Thermometers
http://www.dascosales.com/page16.html

WIKA Bimetal Thermometers
http://www.wika.com/

OAKTON Instruments -- pH meters, thermometers and other equipment: "best qualtiy waterproof instruments, many for under US$100, available from stock from a wide variety of distributors". Contact Bob Langie, 888-462-5866, ext. 5684, e-mail: rlangie@4oakton.com
http://www.4oakton.com

Automatic temperature control valves

Penn Bradshaw water regulating valve, part number is nsv47ab-4. Johnstone Supply, Chattanooga TN. Phone 1 800 5250387, Price US$229.00, pay by credit card.

Danfoss Model AVTA: -25 to +130 C, with +50 to +90 C capillary bulb, opening on rising temp. (can be reversed), differential pressure 0 to 10 bar, max test pressure 25 bar, accuracy of 1% either side.
http://www.danfoss.com/

Metrex 800-T-37SE
http://www.metrexvalve.com/valvesw1.htm

Rustproofing, anti-corrosion

POR-15 -- General rust-proofing, repairing leaking fuel tanks, protecting steel biodiesel processors from corrosion, and more -- a permanent solution.

"POR-15® was tested for 168 hours at 97°F in a condensing humidity salt spray (ASTM B117). At the end of the test period, coated steel was free of rust or pitting. Acid and alkali resistance tests performed found panels coated with POR-15® to be impervious to gasoline, oil, chromic acid, hydrochloric acid, phosphoric acid, sodium hydroxide, caustic soda, 50% sulfuric acid, and 50% hydrofluoric acid. POR-15® was applied over a rusty substrate as a finish coat (approximately 23 mils dry film thickness). The coating showed essentially no undercutting at the scribed area after 2000 hours in a weatherometer.

"A 2 mil thickness of POR-15® was applied to lightly rusted steel and then exposed for 1000 hours to a salt spray. At the end of the test period, no undercutting was observed at the scribed area. Recoatability is excellent. Laboratory tests have shown very good adhesion when applied up to 14 days after application of the first coat. In an actual Field test, a topcoat was applied 6 weeks after the first coat had been applied, and the intercoat adhesion was excellent as determined by a crosshatch tape test. A metal box used as a filter for raw sewage was coated with POR-15® and placed in service within a few hours after the interior and exterior were coated. No visible rusting occurred at the welded areas after a six month exposure.

"A POR-15® coating was subjected to 700°F for 10 hours; it remained hard and showed no apparent loss of adhesion. A panel subjected to elongation was pulled beyond the yield point of the base metal without affecting the POR-15® coating."

We've used it, it works exactly as claimed.
http://www.por15.com/

How to **remove all rust** from steels tools and parts.

General equipment

Universal Process Equipment, Inc. -- used gear at good prices: Evaporators, milling, reactors, extruders, mixers, fermenters, filtration, kilns, glass lined equipment, others, incinerators, complete processes, furnaces, glass lined equipment, heat exchangers, tanks, turbines, generators, centrifuges, chillers, compressors, dryers, boilers, pulverizers. Complete plants available. US-based, deals worldwide.
http://www.upe.com/

Diesel engines

Diesel Engine Trader .com -- New, Remanufactured, Reconditioned diesel engines, Marine Industrial diesel engines, Marine diesel motors, Diesel engine spares -- the HUB for trading diesel engines.
http://dieselenginetrader.com/det_cfm/Index_1.html

Soldering

There's a good primer on **Solder & Brazing** at Tony Ackland's Home Distillation of Alcohol site:

http://www.homedistiller.org/materials.htm#solder

The Brazing Book -- A well-known classic by Handy & Harman, now updated and online in full-text. For both the novice brazer and the seasoned engineer. Five main sections: Section One, "The Idea of Brazing," explains exactly what brazing is, where to use it, and how to perform it properly. Section Two, "Brazing in Action," presents detailed photographic case histories illustrating some of the many applications in which brazing is used today. Section Three, "Choices In Brazing Materials," plus technical reference tables and related information. Section Four, "Available Reference Materials." From The Precious Metals Fabrication Group.
http://www.handyharmancanada.com/TheBrazingBook/bbook.htm

About.com has two useful articles on soldering by **Tammy Powl**. The scale is a bit different -- Tammy's a jewelry maker -- but the principles are the same.
Soldering Tips
http://jewelrymaking.about.com/hobbies/jewelrymaking/library/weekly/aa011199.htm?rnk=r4&terms=silver+solder
Step by Step Soldering
http://jewelrymaking.about.com/hobbies/jewelrymaking/library/weekly/aa011899.htm?rnk=r6&terms=silver+solder

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Biodiesel

Email to Journey to Forever friends, Friday 23 April 1999:

"We turned our kitchen into a sort of illicit still and made a hell of a mess in there brewing biodiesel fuel out of about 60 litres of yukky waste cooking oil we got from behind McDonald's one night (they were happy to give it to us once we told them we didn't want to eat it). We were sure it would work, but we had to make it ourselves first -- we're not chemists, and if we can make it anyone can.

"And it works! Amazing! Last night we put the stuff in Midori's old diesel Land Rover and it ran like a dream and smelt like a bunch of roses! Well, French fried roses anyway. Now it runs clean, on waste Big Mac residues we brewed up in a bucket in the kitchen, and we're very tickled!"

Biodiesel facts

The raw material -- used cooking oil.

Biodiesel is much cleaner than fossil-fuel diesel ("dinodiesel"). It can be used in any diesel engine with no need for modifications -- in fact diesel engines run better and last longer with biodiesel. And it can easily be made from a common waste product -- used cooking oil.

- Biodiesel fuel burns up to 75% cleaner than conventional diesel fuel made from fossil fuels
- Biodiesel substantially reduces unburned hydrocarbons,

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Straight vegetable oil as diesel fuel

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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carbon monoxide and particulate matter in exhaust fumes

- Sulphur dioxide emissions are eliminated (biodiesel contains no sulphur)
- Biodiesel is plant-based and adds no CO2 to the atmosphere
- The ozone-forming potential of biodiesel emissions is nearly 50% less than conventional diesel fuel
- Nitrous oxide (NOx) emissions may increase or decrease but can be reduced to well below conventional diesel fuel levels by adjusting engine timing
- Biodiesel exhaust is not offensive and doesn't cause eye irritation (it smells like French fries!)
- Biodiesel is environmentally friendly: it is renewable, "more biodegradable than sugar and less toxic than table salt" (US National Biodiesel Board)
- Biodiesel can be used in any diesel engine
- Fuel economy is the same as conventional diesel fuel
- Biodiesel is a much better lubricant than conventional diesel fuel and extends engine life -- a German truck won an entry in the Guinness Book of Records by travelling more than 1.25 million km (780,000 miles) on biodiesel with its original engine
- Biodiesel has a high **cetane** rating, which improves engine performance: 20% biodiesel added to conventional diesel fuel improves the cetane rating 3 points, making it a Premium fuel
- Biodiesel can be mixed with ordinary diesel fuel in any proportion -- even a small amount of biodiesel means cleaner emissions and better engine lubrication: 1% biodiesel will increase lubricity by 65%
- Biodiesel can be produced from any fat or vegetable oil, including waste cooking oil.

See the National Biodiesel Board's complete evaluation of biodiesel emissions and potential health effects, in accordance with the most stringent emissions testing protocols ever required by the US EPA (Acrobat file, 213 kb):
http://www.biodiesel.org/news/bulletin/1998/0498.pdf

Summary:

- The overall ozone (smog) forming potential of biodiesel is almost 50% less than diesel fuel.
- Sulfur emissions are eliminated.

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- Substantial reductions of unburned hydrocarbons (-93%), carbon monoxide (-50%), and particulate matter (-30%).
- Biodiesel NOx emissions can be efficiently eliminated as a concern.
- Substantial reductions of cancer-causing PAH (-80%) and nitrited PAH compounds (-90%).

Diesel emissions and cancer

According to a U.S. Department of Energy study completed at the University of California at Davis, the use of pure biodiesel instead of petroleum-based diesel fuel could offer a 93.6% reduction in cancer risks from exhaust emissions exposure.

The study, "Chemical and Bioassay Analyses of Diesel and Biodiesel Particulate Matter", 1996, used a 1995 Dodge 3/4 ton pickup truck with a 5.9-litre Cummins B Turbo diesel and tested 100% ethyl ester of rapeseed oil (REE), 100% diesel 2-D low-sulfur fuel and blends of 20% REE and 50% REE with the 2-D diesel fuel. An EPA test cycle was followed throughout. In test after test the study found the highest risk came from 100% diesel fuel, followed by the 20% REE blend, the 50% REE blend and, lowest risk, the pure biodiesel.

"Use of the 100% REE fuel produced the lowest genotoxic (DNA-damaging) activity in the tests. Blended fuels in the non-catalyst-equipped engine produced less emissions than emissions than the 100% diesel fuel... The use of the 100% REE fuel resulted in the lowest emissions compared to the REE blends and 100% diesel fuels.

"The highest relative specific mass mutagenic activity collected during either the hot or cold test cycles was the particulate matter collected from the 100% diesel fuel emissions... The lowest relative specific mass mutagenic activity was from the particulate matter collected from emissions of l00% REE fuel."

NOTE: There's nothing special about ethyl ester of rapeseed oil biodiesel, other types of biodiesel have similar results.

Chemical and Bioassay Analyses of Diesel and Biodiesel Particulate Matter: Pilot Study -- Final Report
by Norman Y. Kado, Robert A. Okamoto and Paul A. Kuzmicky, Department of Environmental Toxicology, University of California, Davis, California, November 1996.

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Homepage
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Ichijima
Japan

Acrobat file, 3.1Mb.
UC Davis biodiesel study -- summary: the Summary, Results and Discussion sections of the report, in html format.

Greenhouse effect

Using vegetable oils or animal fats as fuel for motor vehicles is in effect running them on solar energy. All biofuels, including ethanol, are derived from the conversion of sunlight to energy (carbohydrates) that takes place in the green leaves of plants.

Plants take up carbon dioxide (CO2) from the atmosphere; burning plant (or animal) products in an engine releases the CO2 uptake back into the atmosphere, to be taken up again by other plants. The CO2 is recycled, atmospheric CO2 levels remain constant. Thus biofuels do not increase the Greenhouse Effect -- unlike fossil fuels, which release large amounts of new (or rather very old) CO2 which has been locked away from the atmosphere for aeons.

In fact biodiesel can actually reduce CO2 levels in the atmosphere: growing soybeans consumes nearly four times as much CO2 as the amount of CO2 produced in the exhaust from soybean oil biodiesel.

Energy efficiency

According to a comparative life-cycle study by the US Department of Energy's National Renewable Energy Laboratory, biodiesel requires only 0.31 units of fossil energy to make 1 unit of fuel.
(An Overview of Biodiesel and Petroleum Diesel Life Cycles)
http://www.ott.doe.gov/biofuels/docs/lifecycle.html

"By contrast, it takes 1.2 units of fossil resources to produce 1 unit of petroleum diesel," the study says.

We wonder what the energy efficiency figures for biodiesel would be if fossil fuels were eliminated from the equation and the entire production process powered by biofuels, from planting the seeds to filling the tank?

Grow your own

Rapeseed (*Brassica Napus*), or canola, produces about 2,000 pounds of seed per acre, yielding about 100 gallons of vegetable oil for fuel, and 1,200 pounds of high-protein meal (seedcake) that can be used for livestock feed or as an organic fertilizer.

The seedcake could also be used to make ethanol, and so could the several tons of crop wastes.

Yields from soybeans are about 60 gallons per acre, from coconuts more than 200 gallons per acre, and from oil palms more than 500 gallons per acre. (See **Vegetable oil yields**.)

For small-timers, one bushel of soybeans produces about 1.5 gallons of biodiesel -- that's about six to one by volume, and three to one for canola (rapeseed).

For a range of oilseed presses, from hand-powered presses you can make yourself to 150-tons per day industrial models, see **Oilseed presses** at our **Biofuels supplies and suppliers** page.

The Sunflower Seed Huller and Oil Press -- by Jeff Cox (from Organic Gardening, April 1979, Rodale Press): Vegetable oils used to be one of those items you just HAD to buy. Now here's how to make your own. In 2,500 square feet, a family of four can grow each year enough sunflower seed to produce three gallons of homemade vegetable oil suitable for salads or cooking and 20 pounds of nutritious, dehulled seed -- with enough broken seeds left over to feed a winter's worth of birds. Online at the Journey to Forever **Biofuels Library**.

"Small-scale Oilseed Processing" by Janet Bachmann, NCAT Agriculture Specialist, Appropriate Technology Transfer for Rural Areas (ATTRA) -- Basic processes involved in small-scale oilseed processing, includes a low-tech method for raw material preparation using sunflower seeds as an example; information on methods and equipment used for oil extraction; notes on clarification, packaging, and storage. Sources for additional information and a list of suitable raw material.
http://www.attra.org/attra-pub/oilseed.html

"The Manual Screw Press for Small-Scale Oil Extraction" by Kathryn H. Potts, Keith MacHell, 1993, Intermediate Technology, ISBN 1853391980
Manual oil extraction from peanuts or other soft oilseeds can be a viable enterprise for

small businesses. Describes small-scale processes of oil extraction for use in rural areas, as well as ways to market and distribute the oilcake. From IT Publishing: http://www.developmentbookshop.com/book.phtml?isbn=1853391980

Official

Biodiesel is recognized by both the **US Environmental Protection Agency** and **Department of Energy** as an alternative fuel, and qualifies for mandated programs under the Clean Air Act Amendments and the Environmental Protection Act of 1992 (EPAct). In California, biodiesel has been approved for use in remediation of petroleum oil spills.

US Department of Energy approval: "Vehicle fleets currently required to purchase light duty alternative fueled vehicles under the Energy Policy Act of 1992 will be now allowed to purchase biodiesel fuel as an alternative, according to the U.S. Department of Energy. Secretary of Energy Spencer Abraham has approved a final rule allowing biodiesel fuel to qualify as an alternative fuel for automobile fleets under the Energy Policy Act." -- U.S. Department of Energy, April 30, 2001. "The continued use of biomass products like biodiesel in our vehicle fleets, for power generation and for other products and materials will help the environment and help diversify our energy resources," said Abraham.

USDA Clears Air with Biodiesel: Buses and other diesel-burning vehicles run cleaner if they mix biodiesel with regular diesel fuel, said the US Department of Agriculture at a biodiesel fuel seminar at a USDA research center. "The program is part of a federal effort to reduce reliance on petroleum and create new markets for US crops," said Floyd P. Horn, administrator of the Agricultural Research Service, USDA's chief scientific agency. "Crop-based diesel burns cleaner, less sooty. One of our goals is to increase the federal government's purchases of bio-based fuel and other products by 10% per year over the next 5 years. We want to encourage the private sector and local governments to do the same." (January 13, 2000) http://www.ars.usda.gov/is/pr/2000/000113.htm

Biodiesel is widely used in Europe. Germany has more than 1,500 filling stations selling biodiesel at the pump. France is the

world's largest producer: all French diesel fuel contains between 2% and 5% biodiesel, and that will soon apply to the whole of Europe.

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Make your own biodiesel

Anybody can make biodiesel. It's easy, you can make it in your kitchen -- and it's BETTER than the petro-diesel fuel the big oil companies sell you. Your diesel motor will run better and last longer on your home-made fuel, and it's much cleaner -- better for the environment and better for health. If you make it from used cooking oil it's not only cheap but you'll be recycling a troublesome waste product. Best of all is the GREAT feeling of freedom, independence and empowerment it will give you. Here's how to do it -- everything you need to know.

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Other uses
Identifying plastics
Separating glycerine/FFAs

Three choices

There are at least three ways to run a diesel engine on bio-power, using vegetable oils, animal fats or both. All three work with both fresh and used oils.

- Use the oil just as it is -- usually called SVO fuel (straight vegetable oil);
- Mix it with kerosene (paraffin) or diesel fuel, or with biodiesel;
- Convert it to biodiesel.

The first two methods sound easiest, but, as so often in life, it's not quite that simple.

1. Mixing it

If you're mixing SVO with kerosene or petroleum diesel ("dinodiesel") you're still using fossil-fuel -- cleaner than most, but still not clean enough, many would say. Still, for every gallon of vegetable oil you use, that's one gallon of fossil-fuel saved, and that much less carbon in the atmosphere.

Most people use a mix of up to 30% kerosene and 70% vegetable oil, some use 50/50 mixes. Some people just use it that

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way, others say it needs at least pre-heating and probably a two-tank system too, like SVO (see below), and we agree with that. The same goes for mixes with vegetable oil and biodiesel -- usually 50/50. In both cases, you might get away with just using it with an older Mercedes 5-cylinder IDI diesel, which is a very tough and tolerant motor. Otherwise, not wise.

So, to be safe, you're going to need what amounts to an SVO two-tank system with heating anyway, so you don't need the kerosene. If you're mixing SVO with biodiesel, you'll use very much less biodiesel by using it in the second tank for start-ups and stops rather than mixing it 50/50. (See next.) Or just use 100% biodiesel and don't bother with two tanks and heating. (See after next.)

Mixes are a poor compromise. But they do have advantages in cold weather. Some kerosene or #1 diesel mixed with biodiesel lowers the temperature at which it starts to gel, and a 50/50 mix with biodiesel will do the same for an SVO system.

Message to the **Biofuel mailing list**:

"I stuck 3 litres of pure rapeseed oil from my local supermarket straight into the tank of my 1998 VW Caddy van. There were about 3-4 litres of dino-diesel in the tank. Once the dino had cleared the fuel lines, I was running on about 50% dino to 50% oil. The only differences I noticed were: A) the engine ran about 10 deg C cooler; B) the exhaust smelt like a roadside burger bar. Apart from that, no problems! As the weather is finally starting to warm up here, I may increase the oil/diesel ratio and see that happens. -- Nick"

Reply:

"One thing that will happen is that your cold starts will begin to deteriorate. Then your filter will probably start plugging. Then your injectors will likely, in time, get coked up. Then the spray pattern will be wonky. Then you'll set the stage for ring sticking, glazing of the cylinder walls, increased lube oil consumption and eventual engine failure -- if you can continue to get the thing started in the morning. More than 20% or so in the diesel is not a good plan for more than short term 'experiments'. Unfortunately, you're not doing anything new here, Nick, and if it was as easy as running high percentages of SVO in diesel, and being able to maintain reliability, we'd all have gone that way long ago. Regards, Edward Beggs, Neoteric Biofuels Inc

Contact us

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Rubber

Pure biodiesel will eventually devour any natural or butyl rubber parts in the fuel system (hoses and seals). Check with the vehicle manufacturer and replace the parts with resistant synthetic parts (such as Viton B). See **Durability of plastics** table. Newer motors don't use rubber. See also **Biodiesel and your vehicle**.

<info@biofuels.ca>

A variation on this theme is adding a solvent to the veg oil to lower the viscosity -- usually 3% white spirit (a.k.a. mineral turpentine, Stoddard solvent, turpentine substitute). This raised a lot of interest after it was publicized on a British TV program -- "just add a spoonful". It also raised a lot of scepticism: "'experimental' at best" was the view of experienced SVO'ers, and "steer well clear" unless you have a 5-cyl IDI Mercedes (in which case you don't even need the white spirit). We agree. Work on blends of SVO with other solvents, such as butanol and ethanol, is still experimental. By all means go ahead and experiment, but there are no guarantees.

2. Straight vegetable oil

With SVO you have to start the engine on ordinary petroleum diesel or biodiesel to warm it up, then switch to the straight vegetable oil, and switch back to petro- or biodiesel before you stop the engine. If you don't do that you'll coke up the engine and the injectors. This means having two fuel tanks -- no simple matter with diesels, which have airtight fuel systems. Using SVO also means pre-heating the oil or it'll be too viscous (thick).

But there's a lot to be said for straight vegetable oil systems -- running on straight vegetable oil while starting up and shutting down on biodiesel can be a clean, effective and economical option.

More information on straight vegetable oil systems **here**.

3. Biodiesel

Biodiesel has some clear advantages over SVO: it works in any diesel, without any conversion or modifications to the engine or the fuel system -- just put it in and go. It also has better cold-weather properties than SVO (but not as good as petro-diesel -- see **Using biodiesel in winter**). And, unlike SVO, it's backed by many long-term tests in many countries, including millions of miles on the road.

Biodiesel is a clean, safe, ready-to-use, alternative fuel, whereas it's fair to say that SVO systems are mostly still experimental and need further development.

On the other hand, biodiesel can be more expensive, depending

what you make it from and whether you're comparing it with new or used oil (and where you live). And, unlike SVO, it has to be processed -- you have to make it. But the large and rapidly growing worldwide band of homebrewers don't seem to mind -- they make a supply every week or once a month and soon get used to it. Many have been doing it for years.

And anyway, you have to process SVO too, especially WVO (waste vegetable oil, used, cooked), which many people with SVO systems use because it's cheap or free for the taking. WVO has to be filtered and dewatered, and probably should be deacidified.

Biodieselers say, "Well, if I'm going to have to do all that I might just as well make biodiesel instead." But SVO types scoff at that -- it's much less processing than making biodiesel, they say. To each his own.

	Needs processing	Guaranteed trouble-free	Engine conversion	Cheaper
Biodiesel	Yes	Yes	No	Sometimes
SVO/WVO	Less	No	Yes	Usually

Costs and prices: Biodieselers using waste oil feedstock say they can make biodiesel for 60 cents US per gallon or less. Most people use about 600 gallons of fuel a year (about 10 gallons a week) -- say US$360 a year. An SVO system costs from $300 to $1,200 or more. So with an SVO system you'll be ahead in a year or two, which is not a long time in the life of a diesel motor. But will it last as long with SVO? Too soon to tell. Probably, if you use a good system. Recommendations, and much more, **here**.

Biodiesel

Converting the oil to biodiesel is probably the best of the three options (or we think so anyway).

You could simply **buy** your biodiesel instead. Most major European vehicle manufacturers now provide vehicle warranties covering the use of pure biodiesel -- though that might not be just *any* biodiesel. Some insist on "RME", rapeseed methyl esters, and won't cover soy biodiesel in the US, but this seems to be more a trade-related issue than a quality-control one.

Germany has more than 1,500 filling stations supplying biodiesel, and it's cheaper than ordinary diesel fuel. It's widely used in France, the world's largest producer. Virtually all fossil diesel fuel sold in France contains between 2% and 5% biodiesel. New EU laws will soon require this Europe-wide. Some states in the US are legislating similar requirements. There's a growing number of US suppliers. Biodiesel is more expensive than ordinary diesel in the US but sales are rising very fast and prices will drop in time. In the UK biodiesel is taxed less than petrodiesel and it's available commercially.

But there's a lot to be said for the GREAT feeling of independence you'll get from making your own fuel (and it's more than just a feeling -- it's real!).

If you want to make it yourself, there are **several good recipes** available for making high-quality biodiesel, and they all say what we also say: some of these chemicals are dangerous, take full safety precautions, and if you burn/maim/blind/kill yourself or anyone else, that will make us very sad, but not liable -- we don't recommend anything, it's nobody's responsibility but your own.

On the other hand, a lot of people are doing it -- it's safe if you're careful and sensible. "Sensible" also mean not over-reacting, as some people do: "I'd like to make biodiesel but I'm frightened of all those terrible poisons." In fact they're common enough household chemicals. Lye is sold in supermarkets and hardware stores as a drain-cleaner, there's probably a can of it under the sink in most households. Methanol is the main or only ingredient in barbecue fuel or fondue fuel, sold in supermarkets and chain stores as "stove fuel" and used at the dinner table; it's also the main ingredient in the fuel kids use in their model aero engines. So get it in perspective, no need to be frightened. See **Safety** for further information. Learn as much as you can first -- **lots of information** is available. Make small **test batches** before you try large batches. Make it with **fresh oil** before you try waste oil.

Where do I start?

Start here: make a test batch of biodiesel using 1 litre of fresh new oil in a blender. If you don't have a spare blender, either get one (you can pick them up quite cheap second-hand), or try **this**. Or, better, make a simple **Test-batch mini-processor**.

Go on, do it! Get some methanol, some lye and some new oil at the supermarket and go ahead -- it's a real thrill!

Here's the recipe, just use 1 litre of oil instead of 10 litres, and 200 ml of methanol instead of 2 litres, with 3.5 grams of lye. **Here's** how to use a blender, and **here's** how to mix the sodium methoxide -- "Methoxide the easy way" (also the safe way).

What's next?

Learn. You have some decisions to make. It's all quite simple really, thousands of people are doing it, very few of them are chemists or technicians, and there's nothing a layman can't understand, and do, and do it well. But there is quite a lot to learn. You should find everything you need to know right here. We've tried to make it easy for you. You start off with the simplest process that has the best chance of success and move on step by step in a logical progression, adding more advanced features

First, here's how we started.

The process

Vegetable oils and animal fats are triglycerides, containing glycerine. The biodiesel process turns the oils into esters, separating out the glycerine. The glycerine sinks to the bottom and the biodiesel floats on top and can be syphoned off.

The process is called transesterification, which substitutes alcohol for the glycerine in a chemical reaction, using lye as a catalyst.

We use methanol to make methyl esters. We'd rather use ethanol because most methanol comes from fossil fuels (though it can also be made from biomass, such as wood), while ethanol is plant-based and **you can distill it yourself**, but the biodiesel process is more complicated with ethanol. (See **Ethyl esters**.)

Ethanol (or ethyl alcohol, grain alcohol -- EtOH, C2H5OH) also goes by various other well-known names, such as whisky, vodka, gin, and so on, but methanol is a deadly poison: first it blinds you, then it kills you, and it doesn't take very much of it. It takes a couple of hours, and if you can get treatment fast enough you might survive. (But don't be put off -- it's easy to do

this safely. Safety is built-in to everything you'll read here.)

Methanol is also called methyl alcohol, wood alcohol, wood naphtha, wood spirits, methyl hydrate (or "stove fuel"), carbinol, colonial spirits, Columbian spirits, Manhattan spirits, methylol, methyl hydroxide, hydroxymethane, monohydroxymethane, pyroxylic spirit, or MeOH (CH3OH or CH4O) -- all the same thing. (But, confusingly, "methylcarbinol" or "methyl carbinol" is used for both methanol and ethanol.) In the US you can usually get it at race tracks.

Methylated spirits (denatured alcohol) doesn't work; isopropyl alcohol (rubbing alcohol) also doesn't work.

The lye catalyst can be either sodium hydroxide (caustic soda, NaOH) or potassium hydroxide (KOH), which is easier to use, and it can provide a potash fertilizer as a by-product. Sodium hydroxide is often easier to get and it's cheaper to use. If you use potassium hydroxide, the process is the same, but you need to use 1.4 times as much. (See **More about lye**.) You can get KOH from soapmakers' suppliers and from chemicals suppliers. Other chemicals, such as isopropyl alcohol (isopropanol) for titration, are available from chemicals suppliers.

CAUTION:
Lye (both NaOH and KOH) is dangerous -- don't get it on your skin or in your eyes, don't breathe any fumes, keep the whole process away from food, and right away from children. Lye reacts with aluminum, tin and zinc. Use glass, enamel, stainless steel or HDPE (High-Density Polyethylene) containers for methoxide. (See **Identifying plastics**.)

See also **Making lye from wood ash**.

Our first biodiesel

This was just an investigative project for us when we made our first biodiesel more than five years ago in Hong Kong. Most of the equipment was improvised. Apart from chemicals and some beakers, syringes and things, the only thing we bought was a set of scales.

We got about 60 litres of used oil (WVO --waste vegetable oil) from

Lantau Island's local McDonald's. There were four 16-litre cans of it, a mix of used cooking oil and residual beef and chicken fats. Two of the tins were solidified, the other two held a gloppy semi-liquid. We warmed it up a bit on the stove (to about 50 deg C) and filtered it through a fine mesh filter, and then again through coffee filter papers, but it was quite clean -- very little food residue was left in the filters.

We'd also bought 10 litres of the cheapest new cooking oil we could find -- we don't know what kind of oil it was, the tins only said "Cooking Oil" -- and used this for our first experiment.

Used cooking oil from McDonald's.

It worked, but we've learnt a lot since then. Now it's easy to make high-quality biodiesel every time without fail. And we don't use open containers for processing now, and neither should you -- and mix the methanol in closed containers too.

Practices, knowledge, technology, equipment and safety measures have all improved tremendously in the last five years since we brewed our first batch, thanks mainly to the collaborative work of thousands of biofuellers worldwide at the **Biofuel mailing list** and other Internet forums.

As a Biofuel list member said in 2002: "I just want to say how important what you all are doing here is. Closed-system fuel production, on a local or small regional scale, tied to local resources, using accessible technologies, and dependent on entrepreneurial innovation combined with open-source information exchange -- it's AWESOME. Keep up the good work everyone, before the planet fries."

Biodiesel from new oil

Make your first test-batch using new oil (fresh, virgin, uncooked). Follow the instructions below, but use 1 litre of oil instead of 10 litres, and 200 ml of methanol instead of 2 litres, with 3.5 grams of lye. Check the quality of your biodiesel with this basic **quality test**.

We had difficulty finding pure methanol in Hong Kong, and eventually paid the very high price of US$10 per litre for 5 litres from a wholesale chemical supply company. It has to be 99% pure or better. (See **How much methanol?**)

In the US, for small test batches, you can get DriGas from the hardware store. One type of DriGas is methanol, another is isopropanol, make sure to get the methanol one.

We used 2 litres of methanol to 10 litres of vegetable oil, and 3.5 grams of pure, granular lye (sodium hydroxide) per litre of oil -- 35 grams for 10 litres. (See **More about lye**.)

You can get lye at most hardware stores (Red Devil lye in the US). Shake the container to check it hasn't absorbed moisture and coagulated into a useless mass, and make sure to keep it airtight.

We had to be quick measuring out the 35 grams of lye required -- summer humidity in Hong Kong is usually about 80% at 30 deg C or more, and the lye rapidly got wet, making it less effective.

We mixed the lye with the 2 litres of methanol in a strong, heatproof glass bottle with a narrow neck to prevent splashing. It fumed and got hot, and took about 15 minutes to mix. See **Methoxide the easy way**. (Use closed containers for mixing methoxide.)

This mixture is sodium methoxide, an extremely powerful base which enjoys eating stuff like human flesh -- take full safety precautions when working with sodium methoxide, have a source of running water handy.

Meanwhile we'd warmed the 10 litres of new oil in a steel bucket on the stove to about 40 deg C (104 deg F) to thin it so it mixed better. In fact, 55 deg C (131 deg F) is a better processing temperature. Don't let it get too hot or the methanol will evaporate. (Methanol boils at 64.7 deg C, 148.5 deg F.)

We'd made a wooden jig with a portable vice clamped to it holding a power drill fitted with a paint mixer to stir the contents of the bucket. This did a good job without splashing.

Midori checks the temperature of the oil.

Stirring well, we carefully added the sodium methoxide to the oil. The reaction started immediately, the mixture rapidly separating into a clear, golden liquid on top with the light brown glycerine settling out at the bottom. We kept stirring for an hour, keeping the temperature constant. Then we let it settle overnight.

The next day we syphoned off 10 litres of biodiesel, leaving two litres of glycerine in the bottom of the bucket.

Biodiesel from waste oil

This is more appealing than using new oil, but it's also more difficult.

First, check for water content. Used oil often has some water in it, and water in the oil will interfere with the lye, especially if you use too much lye, and you'll end up with jelly. Test first for water content -- heat half a litre or so in a saucepan on the stove and monitor the temperature with a thermometer. If there's water in it it will start to "snap, crackle and pop" by 50 deg C (120 deg F) or less. See **Removing the water.** If it's still not crackling by 60 deg C (140 deg F) there's no need to dewater it.

Here's another way, from **Aleks Kac** -- it uses less energy and doesn't risk forming more Free Fatty Acids (see below) by overheating. Heat the oil to 60 deg C (140 deg F), maintain the temperature for 15 minutes and then pour the oil into a settling tank. Let it settle for at least 24 hours. Make sure you never empty the settling vessel more than 90%.

Waste oil needs more catalyst than new oil to neutralize the Free Fatty Acids (FFAs) formed in cooking the oil, which interfere with the transesterification process.

You have to titrate the oil to determine the FFA content and how much lye will be required to neutralize it. This means determining the pH -- the acid-alkaline level (pH7 is neutral, lower values are increasingly acidic, higher than 7 is alkaline).

An electronic pH meter is best, but you can also use pH test strips (or litmus paper), or phenolphthalein solution (from a chemicals supplier).

We also thought of using red cabbage juice, which changes from red in a strong acid, to pink, purple, blue, and finally green in a strong alkali (see **Natural test papers**). We didn't have a pH meter then so we used phenolphthalein solution. Phenolphthalein is colorless up to pH 8.3, then it turns pink (or rather magenta), and red at pH 10.4.

Dissolve 1 gm of lye in 1 litre of distilled water (0.1% lye solution). In a smaller beaker, dissolve 1 ml of the cooled oil in 10 ml of pure isopropyl alcohol. Warm the beaker gently by standing it in some hot water, stir until all the oil dissolves in the alcohol and turns clear. Add 2 drops of phenolphthalein solution.

Keith checks the pH of the waste oil.

Using a graduated syringe, add 0.1% lye solution drop by drop to the oil-alcohol-phenolphthalein solution, stirring all the time, until the solution starts to turn pink and stays that way for 10 seconds. Take the number of millilitres of 0.1% lye solution you used and add 3.5. This is the number of grams of lye you'll need per litre of oil. (See **Better titration**.)

Our first titration took 6 ml of 0.1% lye solution(not very good oil), so we used 6 + 3.5 = 9.5 grams of lye per litre of oil: 95 grams for 10 litres.

Then proceed as with new oil: measure out the lye and mix it with the methanol to make sodium methoxide -- it will get even hotter and take longer to mix, as there's more lye this time. Make sure the lye is completely dissolved in the methanol.

Carefully add the sodium methoxide to the warmed oil while stirring, and mix for an hour. Settle overnight, then syphon off the biodiesel.

The first five times we did this, using 10 litres of waste oil each time, we got biodiesel (a bit darker than the new oil product) and

glycerine three times, and twice we got **jelly**. The answer is to be more careful with the titration: do it twice, just to be sure. Read on, and you'll learn how to make high-quality biodiesel every time, without fail.

The production rate was less than with new oil, ending with 8-9 litres of biodiesel instead of 10. The acid-base **Foolproof method**, developed since, will get much higher production rates with heavily-used oil.

Check the quality of your biodiesel with this basic **quality test**.

For a more detailed description of making biodiesel from WVO, see **Mike Pelly's method**.

Washing

Biodiesel should be washed to remove soap, catalyst and other impurities. Some people insist on it, others don't and argue that the small amounts of impurities cause no engine damage.

We recommend washing it. In fact we insist on it -- good-quality biodiesel must be washed.

See **Bubble washing**

Using biodiesel

You don't have to convert the engine to run it on biodiesel, but you do need to make some adjustments and check a few things.

Retard the injection timing by 2-3 degrees -- this overcomes the effect of biodiesel's higher **cetane** number. It also causes the fuel to burn cooler, thus reducing **NOx emissions**.

Petro-diesel leaves a lot of dirt in the tank and the fuel system. Biodiesel is a good solvent -- it tends to free the dirt and clean it out. Be sure to check the fuel filters regularly at first. Start off with a new fuel filter.

Check there are no natural rubber parts in the fuel system. If there are, replace them. Viton is best.

See **Biodiesel and your vehicle**

Safety

Wear proper protective gloves, apron, and eye protection and do not inhale any vapors. Methanol can cause blindness and death, and you don't even have to drink it, it's absorbed through the skin. Sodium hydroxide can cause severe burns and death. Together these two chemicals form sodium methoxide. This is an extremely caustic chemical. These are dangerous chemicals -- treat them as such! Gloves should be chemical-proof with cuffs that can be pulled up over long sleeves -- no shorts or sandals. Always have running water handy when working with them. The workspace must be thoroughly ventilated. No children or pets allowed.

Organic vapor cartridge respirators are more or less useless against methanol vapors. Professional advice is not to use organic vapor cartridges for longer than a few hours maximum, or not to use them at all. Only a supplied-air system will do (SCBA -- Self-Contained Breathing Apparatus).

The best advice is not to expose yourself to the fumes in the first place. The main danger is when the methanol is hot -- when it's cold or at "room temperature" it fumes very little, and this is easily avoided. Don't use "open" reactors -- **biodiesel processors** should be closed to the atmosphere, with no fumes escaping. All methanol containers should be kept tightly closed anyway to prevent water absorption from the air.

We transfer methanol from its container to the methoxide mixing container by pumping it, with no exposure at all. This is easily arranged, and an ordinary aquarium air-pump will do (the same one you use for washing the biodiesel). The methoxide is mixed like this -- **Methoxide the easy way**, which also happens to be the safe way. The mixture gets quite hot at first, but the container is kept closed and no fumes escape. When mixed, the methoxide is again pumped into the (closed) biodiesel processor with the aquarium air-pump -- there's no exposure to fumes, and it's added slowly, which is optimal for the process and also for safety. See **Adding the methoxide**.

Once again, making biodiesel is safe if you're careful and sensible. "Sensible" also mean not over-reacting, as some people do: "I'd like to make biodiesel but I'm frightened of all those terrible poisons." In fact they're common enough household chemicals. Lye is sold in supermarkets and hardware stores as a

drain-cleaner, there's probably a can of it under the sink in most households. Methanol is the main or only ingredient in barbecue fuel or fondue fuel, sold in supermarkets and chain stores as "stove fuel" and used at the dinner table; it's also the main ingredient in the fuel kids use in their model aero engines. So get it in perspective: be careful with these chemicals -- with ALL chemicals -- but there's no need to be frightened of them.

For fire risks, see **Hazards**

Next: **Make your own biodiesel -- Page 2**

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Two-stage biodiesel process
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Mike Pelly's biodiesel method

Getting ready for the fair... Mike promotes biodiesel wherever he can.

Mike Pelly lives in the US North West. "I live for renewable energy projects," he says. Mike's been making his own biodiesel fuel from waste cooking oil for the last five years, using it in several different cars. He finds it "far superior" to fossil-based diesel fuel.

Mike sent us a full report on how he makes biodiesel. "It's a result of my work over the past five years along with contributions from other experimenters," he said. "Pass it along to anyone you please." Here it is.

Biodiesel From Used Kitchen Grease or Waste Vegetable Oil

by Mike Pelly

Mike's new biodiesel processor

This is how to make your own biodiesel fuel from used cooking oil. The oil -- waste vegetable oil (WVO), used fryer grease, animal fats, lard -- is often free for the taking. All you need is a few common chemicals and some equipment you can easily buy or make yourself. The result is a cheap, clean-burning, non-toxic, renewable, high-quality diesel motor fuel you can use in your car without modifications.

CAUTION:

Wear proper protective gloves, apron, and eye protection and do

Biodiesel and your vehicle
Food or fuel?
Straight vegetable oil as diesel fuel

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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Ethanol resources on the Web
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not inhale any vapors. Methanol can cause blindness and death, and you don't even have to drink it, it's absorbed through the skin. Sodium hydroxide can cause severe burns and death. Together these two chemicals form sodium methoxide. This is an extremely caustic chemical. These are dangerous chemicals -- treat them as such! Always have a hose running when working with them. The workspace must be thoroughly ventilated. No children or pets allowed. See **Safety** for further information.

The Seattle Times
All West Coast ports closed again
Cooking oil can fuel the car after it helps feed the driver
U.S. military presence grows all around Iraq

Mike makes front-page news in **The Seattle Times**, September 30, 2002

Making biodiesel

Ingredients

Mixture:
Waste vegetable oil (WVO) -- used cooking oil, fryer grease, animal fats, lard
Methanol (CH3OH) -- 99%+ pure
Sodium hydroxide (NaOH -- caustic soda, lye) -- must be dry

Titration:
Isopropyl alcohol (rubbing alcohol) -- 99%+ pure
Distilled water
Phenolphthalein solution (not more than a year old, kept protected from strong light) -- "Phenol" or "Phenol Red" from swimming pool or hot tub supply stores may not be the same as phenolphthalein; it can be used but the directions for use may be different

Washing:
Vinegar
Water

See **"Make fuel from used kitchen grease"** by Mike Pelly in the Jan/Feb 2001 issue of Countryside Magazine.

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Procedure

1. Filter WVO to remove any food scraps or solid particles.
2. Heat WVO to remove any water content (optional).
3. Perform titration to determine how much catalyst is needed.
4. Prepare sodium methoxide.
5. Heat WVO, mix in the sodium methoxide while stirring.
6. Allow to settle, remove the glycerine.
7. Wash and dry.
8. Check quality.

This procedure is called transesterification, similar to saponification. Sound familiar? Saponification is soap making. To make soap you take a transfatty acid or triglyceride (oil or kitchen grease) and blend it with a solution of sodium hydroxide (NaOH, caustic soda or lye) and water. This reaction causes the ester chains to separate from the glycerine. These ester chains are what becomes the soap. They're also called lipids. Their unique characteristic of being attracted to polar molecules such as water on one end and to non-polar molecules like oil on the other end is what makes them effective as soap.

In transesterification, lye and methanol are mixed to create sodium methoxide (Na+ CH3O-). When mixed in with the WVO this **strong** polar-bonded chemical breaks the transfatty acid into glycerine and also ester chains (biodiesel), along with some soap if you're not careful (more on that later). The esters become methyl esters. They would be ethyl esters if reacted with booze (ethanol) instead of methanol.

Figures 1-3 show these two reactions. The zigzag lines in the triglyceride diagram (Figure 1) are shorthand for carbon chains. At both ends of each line segment is a carbon atom.

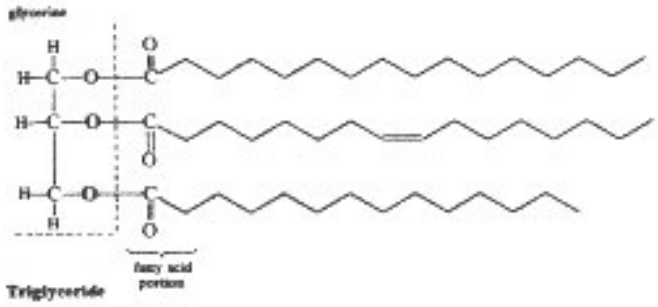
Scale for measuring out lye and chemical supplies used for a titration.

Sample of used oil about to be titrated.

Color of titrated liquid sample when at the correct pH.

Weighing correct amount of lye.

Figure 1



In Figures 2 and 3 these zigzags are shorthanded as R1, 2 and 3.

Figure 2

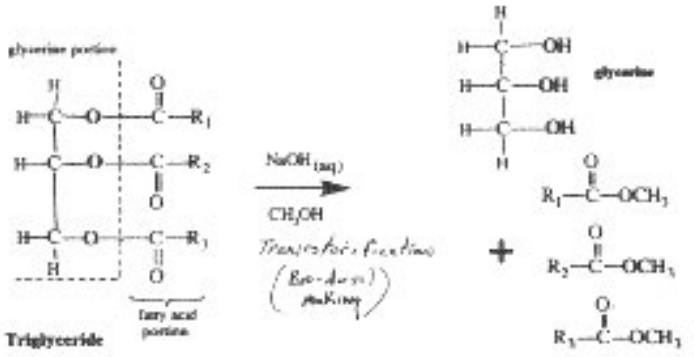
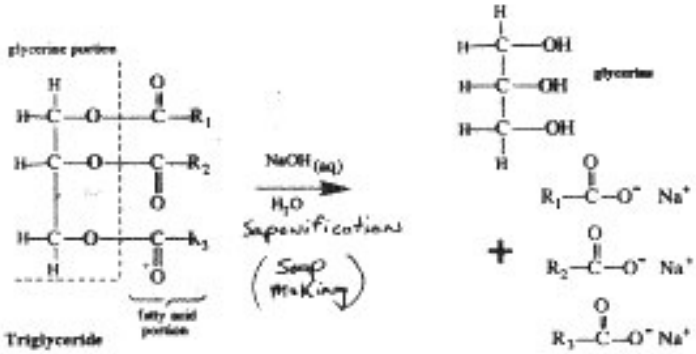


Figure 3



1. Filtering

Filter the WVO to remove food particles. You may have to warm it up a bit first to get it to run freely, 95 deg F (35 deg C) should be enough. Use a double layer of cheesecloth in a funnel, or a restaurant or canteen-type coffee filter.

2. Removing the water

Many people heat the WVO first to remove any water content. Waste oil will probably contain water, which can slow down the reaction and cause saponification (soap formation). The less water in the WVO the better.

Lighting burner under transesterifyer vessel.

View of sodium methoxide mixer (left) and transesterifyer vessel (right).

View of sodium methoxide mixer being drained into transesterifyer vessel (note thermometer).

Valve on bottom of transesterifyer vessel user to decant out more dense glycerin from less dense esters.

Mike and Joe, an organic farmer who makes 40 gallons of biodiesel a week for the farm truck and tractor.

This is how they do it. Raise the temperature to 212 deg F (100 deg C), hold it there and allow any water to boil off. Use the mixer to avoid steam pockets forming below the oil and exploding, splashing hot oil out of the container. Or drain water puddles out from the bottom as they form -- you can save any oil that comes out with the water later.

When boiling slows, raise the temperature to 265 deg F (130 deg C) for 10 minutes. Remove heat and allow to cool.

You may be lucky and find a regular source of WVO that doesn't need to have the water boiled off, in which case don't do it -- boiling means extra energy and time. Personally I don't boil off the water first, I'd rather avoid the extra step in the process and save the energy it uses. But unless you're sure, it may be better to be on the safe side.

3. Titration

To determine the correct amount of lye required, a titration must be performed on the oil being transesterified. This is the most difficult step in the process, and the most critical -- make your titration as accurate as possible.

IMPORTANT: The lye must be dry -- keep it away from water, store it in an airtight container.

Make up a solution of one gram of lye to one liter of distilled water. Make sure it dissolves completely. This sample is then used as a reference tester for the titration process. It's important not to let the sample get contaminated, it can be used for many titrations.

Mix 10 milliliters of isopropyl alcohol in a small container with a 1 milliliter sample of WVO -- make sure it's exactly 1 milliliter. Take the WVO titration sample from the reaction vessel (Figure 5 #1) after it's been warmed up and stirred.

Add to this solution 2 drops of phenolphthalein, an acid-base

Fuel pump and filters -- these are used last, after soapy residues and lye have had time to settle out of biodiesel.

Overview of trailer-mounted processor: propane tank is for heating grease, PVC containers on either side are soap settling tanks for biodiesel prior to pumping through filters. Pick-up line for filter pump is inserted into tank only deep enough to siphon esters and not soaps on bottom.

The finished product.

Mike's original 5 gallon

indicator that's colorless in acid and red in base.

IMPORTANT: Phenolphthalein has a shelf life of about a year, it is very sensitive to degradation by light so after a while it will start giving erroneous readings.

Using a graduated eye dropper (with increments marked in tenths of milliliters) or some other calibrated instrument (from medical supply outlets), while carefully keeping track of the amounts, drop measured amounts of the lye/water solution a couple of tenths of milliliters at a time into the WVO/isopropyl/phenolphthalein solution.

Follow each drop with vigorous stirring of the solution. In cold weather the WVO might congeal and not work so you might need to do the titration in a heated room. If conditions are right eventually the solution turns pink (magenta), and stays pink for 10 seconds. This is the indicator color for a pH range of 8-9 (see the photograph in the left column of this page, "Color of titrated liquid sample when at the correct pH"). It's important to find the exact amount, to just reach this pH without dropping in too much!

It's a good idea to do this entire process more than once to ensure that your number is correct. I've found that depending on the type of WVO, how hot it got in the fryer, what was cooked in it and how long it was used, the amount of lye/water solution needed to titrate it is usually 1.5 to 3 milliliters. You can also use litmus paper or a digital pH tester instead of the phenolphthalein. Try it with fresh cooking oil from your kitchen too, it should need much less lye to reach pH 8-9.

The calculation

The next step is to determine the amount of lye needed for the reaction. Take the number of milliliters derived from the titration and multiply by the number of liters of WVO to be transesterified.

There is one more thing to be included in the calculation. Every liter of neat vegetable oil (fresh -- never been cooked) needs 3.5 grams of lye for the reaction. So for every liter of WVO to be transesterified add an additional 3.5 grams of lye.

Example: The titration determined that it took 2.4 milliliters to reach pH 8-9 and you'll be transesterifying 150 liters of oil.

biodiesel mill.

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2.4 grams times 150 liters equals 360 grams lye

Plus 3.5 grams times 150 liters equals 525 grams lye

360 + 525 = 885 grams lye

If the titration result was 1.8 milliliters to reach pH 8-9, the final amount of lye needed for the reaction would be 795 grams.

I've found over time that the number of grams of lye needed per liter of WVO has generally been between 6 and 7.

Test batches

The first few times you do this process or if you're planning on transesterifying a lot of WVO it is a good practice to first try out your lye amounts on a 1 liter batch in a kitchen blender. This works really well and you don't need to heat up the WVO too much, just enough so it will spin well in the blender. Blenders are very thorough at mixing the ingredients so heating is not as critical.

Start by mixing up the lye and methanol in a blender (one that will never be used for food again). First make sure the blender and all utensils used are dry. Forming the exothermal sodium methoxide polar molecule will heat up the blender container a bit. Keep mixing until all the lye has been dissolved.

Once the sodium methoxide is prepared, add to the blender 1 liter of WVO. Make certain all your weights and volumes are precise. If you're unsure of the titration result numbers then use 6-6.25 grams of lye per liter of used WVO, or 3.5 grams for fresh vegetable oil. Blender batches need only be run for about 15-20 minutes for separation to be completed before switching off. The settling takes some time to complete. The solution can be poured from the blender into another container right after switching off the blender.

It is good to do a few batches with varying amounts of lye recorded so later when checking results one can choose the lye quantity that did the best job.

When too much lye is used the result can be a troublesome gel that is tough to do anything with. (See Glop soap.) When not enough lye is used the reaction does not go far enough so some unreacted WVO will be mixed with the biodiesel and glycerine.

This will form three levels with biodiesel on top above unreacted WVO with glycerine on the bottom. If there is too much water in the WVO it will form soaps and settle right above the glycerine forming a fourth level in the container. This layer is not too easy to separate from the unreacted WVO and glycerine layers.

4. Preparing the sodium methoxide

Generally the amount of methanol needed is 20% of the WVO by mass. The densities of these two liquids are fairly close so measuring 20% of methanol by volume should be about right. To be completely sure, measure out a half-liter of both fluids, weigh, and calculate exactly what 20% by mass is. Different WVOs can have different densities depending on what type of oil it originally was and how long it was used in the deep fryer.

Example: When transesterifying 100 liters of WVO, use 20 liters of methanol.

The methanol is mixed into a solution with the sodium hydroxide (lye), creating sodium methoxide in an exothermic reaction (ie it gets warm from bonds forming). Keep all utensils the lye comes in contact with as dry as possible.

CAUTION:
Treat sodium methoxide with extreme caution! Do not inhale any vapors! If any sodium methoxide gets splashed on your skin, it will burn you without your feeling it (killing the nerves) -- wash immediately with lots of water. Always have a hose running when working with sodium methoxide.

Sodium methoxide is also very corrosive to paints. Lye reacts with aluminum, tin and zinc. Use glass, enamel or stainless steel containers -- stainless steel is best. Used restaurant equipment supply stores and scrap metal recycling yards are two good places to look for this type of equipment. Braze on plumbing fittings for drains, etc. where needed.

5. Heating and mixing

Pre-heat waste vegetable oil reclaimed from a restaurant's waste grease barrel to 120-130 deg F (48-54 deg C).

A propeller or paint stirrer coupled to a 1/2-inch electric drill held securely in a jig works fine as a mixer.

Too much agitation causes splashing and bubbles through vortexing and reduces mix efficiency. There should be a vortex just appearing on the surface. Adjust the speed, or the pitch or size of the stirrer to get the right effect.

If you want a quieter processor, an electric pump plumbed to form a mixing loop for stirring the WVO would do a nice job. Mount the pump above the level that glycerine will gel at to prevent clogging up the pump (see below).

Add the sodium methoxide to the WVO while stirring; stir the mixture for 50 minutes to an hour. The reaction is often complete in 30 minutes, but longer is better.

The transesterification process separates the methyl esters from the glycerine. The CH3O of the methanol then caps off the ester chains and OH from the NaOH (lye) stabilizes the glycerine.

6. Settling and separation

Allow the solution to sit and cool for at least eight hours, preferably longer. The methyl esters -- biodiesel -- will be floating on top while the denser glycerine will have congealed on the bottom of the container forming a hard gelatinous mass (the mixing pump must be mounted above this level).

An alternative method is to allow the reactants to sit for at least an hour after mixing while keeping the brew above 100 deg F (38 deg C), which keeps the glycerine semi-liquid (it solidifies below 100 deg F). Then carefully decant the biodiesel.

This can be done by draining the reactants out of the bottom of the container through a transparent hose. The semi-liquid glycerine has a dark brown color; the biodiesel is honey-colored. Keep a watch on what flows through the sight tube: when the lighter-colored biodiesel appears divert it to a separate container. If any biodiesel stays with the glycerine it is easy to retrieve it later once the glycerine has solidified.

If you left the mixture in the tank until the glycerine gelled, reheat the tank just enough to liquify the glycerine again. Don't stir it! Then decant it out as above.

Figure 4 shows one example of a system for separating two liquids with different densities. This could make a good pre-filter

or be used to separate oils, soap and glycerine/esters goop. Marine/boat fuel cleaning systems do a good job of filtering.

Figure 4 **Figure 5**

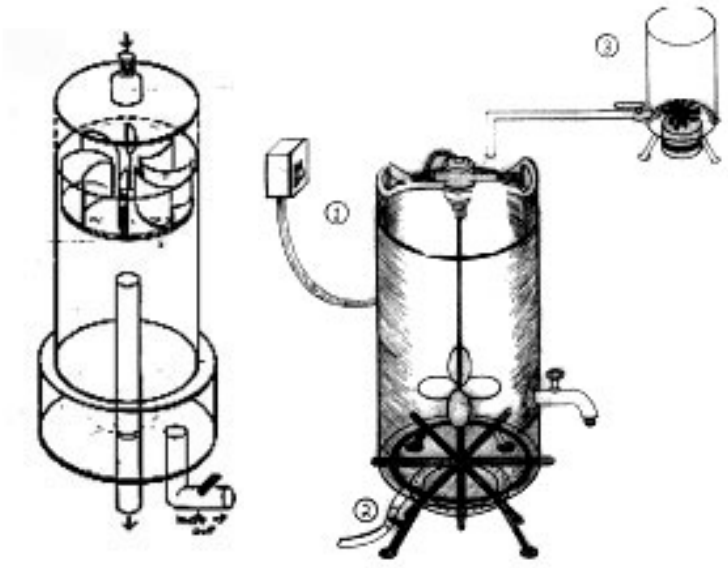
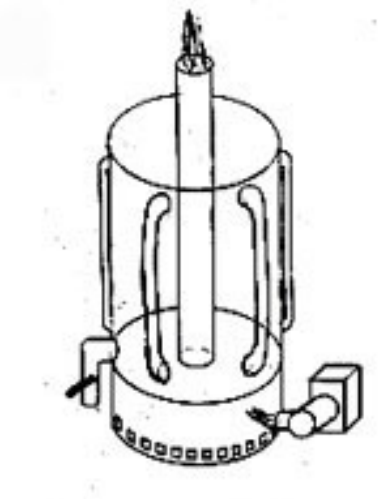


Figure 5 shows the reaction vessel (#1) where the WVO is mixed (also could be done with a pump) and heated. Heating is accomplished by (#2) a hotplate, propane-burner, or a diesel stove would work well.

Figure 6



A proposed alternative using very little electricity is illustrated in Figure 6. This system would use a furnace-type burner run on reclaimed esters to heat its reaction vessel. The vessel's stirring action is created by thermo inversion currents generated by the vessel's external cooling tubes and a baffled exhaust vent that runs up through its center.

Figure 5 also shows a blender (#3) used to mix up the sodium methoxide. When making 16 liter (5 gal) batches, I use a yard-sale glass blender for the sodium methoxide solution (and for nothing else!), but I can't fit it all in at once, so I measure out three separate portions.

Glycerine

The glycerine from WVO is brown and usually turns to a solid

below about 100 deg F (38 deg C). Glycerine from fresh oil often stays a liquid at lower temperatures.

Reclaimed glycerine can be composted after being vented for three weeks to allow residual methanol to evaporate off or after heating it to 150 deg F (66 deg C) to boil off any methanol content (the boiling point of methanol is 148.5 deg F, 64.7 deg C). The excess methanol can be recovered for re-use when boiled off if you run the vapors through a condenser.

Another way of disposing of the glycerine, though a great bit more complicated, would be to separate its components, mostly methanol, pure glycerine (a valuable product for medicines, tinctures, hand lotions, dried plant arrangements and many other uses -- see **Glycerine**) and wax. This is often accomplished by distilling it, but glycerine has a high boiling point even under high vacuum so this method is difficult.

I was able to find someone who could use my glycerine (for dried flower arrangements) through the Industrial Materials Exchange (IMEX) in Seattle. IMEX has a publication that comes out every other month with listings, looking for and offering all types of surplus industrial materials. Many areas have similar exchanges.
http://www.metrokc.gov/hazwaste/imex/

The glycerine by-product makes an excellent industrial-type degreaser/soap. One way to purify it is heat it to 150 deg F (65.5 deg C) to boil off excess methanol, making it safe for skin contact (take precautions with fumes). Once the glycerine is back to a liquid the impurities sink to the bottom and the color will become a more uniform dark brown. This can be cut with water leaving it a tan color, less concentrated and softer and easier to handle when washing hands. Produced this way the degreaser could be sold in squeeze or pump dispensers.

Other ideas for disposing of the glycerine are breaking it down to usable methane gas, with a methane digester or, for a much wilder idea, it could be broken down with pyrolisis. Pyrolisis was used extensively to run cars on firewood in oil-scarce Europe and elsewhere during World War 2. The processor has a heat source that heats the fuel (wood or glycerine) in an airtight box without oxygen. This allows the fuel to release its methane while not allowing it to burn. The methane is trapped in an inflatable storage container or compressed into a tank. This is an area of biodiesel development that warrants further work.

Soap residue

Suspended in the biodiesel will also be some soapy residues. These are the result of Na+ ions from the sodium hydroxide (NaOH) reacting with water created when the methanol bonds with the ester chains along with any other water that was suspended in the WVO.

If the reaction produces more than the usual amount of soap, this happens when lye comes into contact with water before it has a chance to react with the WVO -- in this case the excess water should have been boiled off first. (See Step 2, above, Removing the water.)

The part of the process where it's vital to keep all water out of the reaction is when making the sodium methoxide. Keep the blender and all utensils the lye comes in contact with as dry as possible. The chances of a good clean splitting of esters from glycerine with little soap by-product are much better on a warm dry summer day than on a damp winter day.

7. Washing and drying

There is more than one school of thought on getting the biodiesel from this stage to the fuel tank. One is to let it sit for a while (about a week), allowing the majority of the soap residues to settle before running the biodiesel through a filtration system then into the vehicle/home fuel tank.

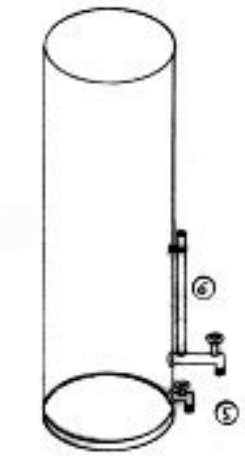
Another method is to wash the soaps out of the fuel with water, one or more times. When washing biodiesel the first time it's best to add a small amount of acetic acid (vinegar) before adding the water. The acetic acid brings the pH of the solution closer to neutral because it neutralizes and drops out any lye suspended in the biodiesel.

Figure 7 shows a simple way of washing using a translucent PVC type container with a valve 3-4 inches from bottom. For 5 gallon batches use those 5-7 gallon buckets found everywhere these days. If a translucent container can't be found one fabricated with a sight tube (#6) ought to work.

Fill with water until it is halfway between the container's bottom and the valve, then fill up with the biodiesel to be washed. After a gentle stirring (keep it gentle, you don't want to agitate up

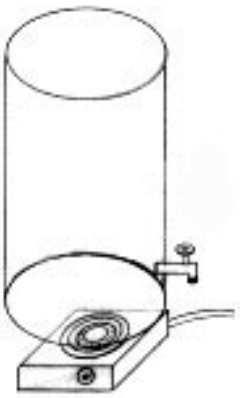
soaps) followed by 12-24 hours of settling, the oil and water will separate, the cleaned oil can be decanted out the valve, leaving the denser soapy water to be drained out the bottom (#5).

Figure 7



This process might have to be repeated two or three times to remove close to 100% of soaps. The second and third washings can be done with water alone. After the third washing any remaining water gets removed by re-heating the oil slowly (Figure 8), the water and other impurities sink to bottom. The finished product should be pH 7, checked with litmus paper or with a digital pH tester.

Figure 8



The water from the third wash can be used for the first or second washes for the next batch. The impurities can be left in the re-heater for the next batch and removed when it accumulates. The soaps can be concentrated, left-over biodiesel can be decanted out and what's left is a biodegradable soap good for many industrial-type uses (degreasers etc.).

I had some success with trapping the concentrated very hydrated sodium from this soap. The way I did this was by pouring the soap onto a stretched cheese cloth and allowing the water to run through leaving the sodium on the cloth. This is as far as I've gone with this so far but it seems one could press much of the water from the sodium then vacuum dessicate this saturated sodium under dry conditions back to a usable sodium hydroxide.

Transesterified and washed biodiesel will become clearer over time as any remaining soaps drop out of the solution.

Another idea I have been working with is chilling down the biodiesel thus allowing the soaps to condense and settle out faster. When the oil gets chilled it seems to speed up the settling of the residual lye. With a short settling time the oil clears considerably.

Bubble washing

Some experimenters are getting good results with the Idaho

bubble washing technique. It takes longer, but uses less water. They find it very effective, giving a clean, polished product.

Here's how they do it. The bubbles are formed by compressed air passing through an air stone. For a small installation, buy an aerator at an aquarium shop -- they come in several sizes and cost about $10 to $40. Sometimes they have a filter attached -- throw it away.

Add about 30 milliliters of vinegar (acetic acid) per 100 liters of biodiesel and then about 50% water. Then drop in the air stone.

The air stone sinks to the bottom of the tank. When you switch on the aerator, the air bubbles rise through the biodiesel, carrying a film of water which washes the biodiesel as it passes through. At the surface, the bubble bursts, leaving a small drop of water which sinks back down through the biodiesel, washing again.

If the mixture is still cloudy after a couple of hours, add a little more vinegar.

Bubble-wash for 12 hours or longer (up to 24), then drain off the washing water, skim off any wax floating on top. Repeat the bubble wash two more times; keep the water from the 2nd and 3rd wash for washing the next batch.

For severe soap formations, first heat the biodiesel/soap mixture to 122 deg F (50 deg C). Add enough vinegar to bring the pH to slightly below 7. Stir for half an hour, cool and continue with bubble drying as usual.

See also **Bubble washing**

8. Quality

The quality of the fuel product can be checked by visually examining it and checking its pH. The pH of the finished product can be checked with pH paper or a digital tester. It should be neutral (pH 7). It should look like clear vegetable oil with a light brown tint, similar to filtered apple cider.

There are not supposed to be any films, particles or cloudiness to it. Films would be remaining soapy residue, re-wash or re-filter it at 5 micron or finer. Cloudiness would be water still in it, re-heat it. Particles could be anything and indicates the filter is failing.

Any oils will clear up considerably when heated but the test is, when it cools back down is it still clear? If it is not yet clear then allowing it to settle out for an additional week or two should be enough to clear it up.

For final filtering it is best to use a marine-type fuel filter -- the ones with a transparent canister so it is possible to keep an eye on the fuel's clarity. I used to trust when I washed it to just pouring fuel into the tank through folded cheesecloth in a funnel. After running into an increased number of dirty fuel filters I've become more careful.

It is important to know also that biodiesel does a great job of cleaning up fossil diesel fuel films coating the interior parts of any old diesel engine. For this reason, take care to check and change your vehicle's fuel filters when first switching over to biodiesel. I like putting a small, cheap, clear or translucent plastic in-line fuel filter right before my vehicle's stock filter. This will prefilter the fuel before it reaches the vehicle's fuel filter, which is more expensive to replace. This also makes it easy to see when fuel is flowing and to keep an eye on the condition of the filter.

Limitations

Biodiesel does have some limitations. First it has cold-weather starting problems. Depending on the type of oil used, around 40 deg F (4-5 deg C) it may start to solidify. (See "**Talking about the weather**".) One remedy is to mix with a proportion of fossil diesel. Or try a Racor or Diesel-Therm electric fuel heater. Heated garages are nice too. Some people report that standard antigelling compounds work fine, others say they're unpredictable. (Be aware that antigelling agents can be highly toxic.)

Another cold-weather idea is the two-stage method recommended by **Aleks Kac**. He has found that doing the reaction this way leaves him with a fuel that works better in colder conditions.

Retard the injection timing by 2-3 degrees -- this overcomes some of the effect of biodiesel's higher **cetane number**. The engine loses a bit of the extra power you get with biodiesel, but it runs quieter and the fuel burns cooler, reducing NOx emissions. (See also **NOx emissions and biodiesel**.)

There can be an increased rate of corrosion of rubber parts in the fuel system over time with 100% biodiesel. Newer cars do not use rubber parts. Biodiesel has been used in many older motors without any problems. Viton parts are best, but others are just as good. Check this table: "Durability of Various Plastics: Alcohols vs. Gasoline", see Methanol.

See also **Biodiesel and your vehicle**.

For anyone interested in biodiesel and other renewable energy sources I encourage you to look through the extensive Journey to Forever website. This is a most exciting project so please spread the word about it.

Thanks go to Keith and Midori at Journey to Forever, the creators of The Fat of The Land video, to Tom Reed for the assistance he gladly dispensed to me when I first got started, Aleks Kac, Terry de Winne ("Terry UK"), Dave Elliott ("Dave UK"), Bill Battagin, Martin Steele, Peter Pessiki at the Evergreen State College (TESC) in Olympia, Washington, USA, and the many interesting and generous contributors at The Biodiesel Discussion Group and Message Board.

Have fun with it. And be safe!

For any questions or comments on how this project works out for you I can be reached at Renewablenergies@yahoo.com. And once you have a system up and running send pictures and how-to's to info@journeytoforever.org so we all can share what you have learned.

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Mike's method in **Spanish**: Formula de Mike Pelly
http://journeytoforever.org/energiaweb/mike.htm

Mike's company, **Olympia Green Fuels** in Olympia, Washington.
http://www.olympiagreenfuels.com/

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The two-stage adaptation of Mike Pelly's biodiesel recipe

By Aleks Kac

Note: Many biofuellers are using this method and report high-quality results. Aleks has since evolved the process -- see the **FOOLPROOF biodiesel method**

The two-stage processes are advanced methods, **not for novices** -- learn the basics thoroughly first. The single-stage base method is the place to start. **Start here**.

Introduction

For some time now a growing group of people have been trying and succeeding to make diesel fuel out of used cooking oil (waste vegetable oil, WVO) by themselves. There are many magnificent articles on this subject on the Internet that can teach you how to get started.

Here is a proposition for an alternative method, which can give you a slightly purer type of biodiesel. It will come in handy during winters, as with this adaptation less wax and ignition problems will arise -- at least I hope so.

I believe that everyone has paid a visit to Mike Pelly's recipe at some point in their DIY biofuel-production learning stage -- if you haven't you should do it soon. This article will give you a good explanation of the ester splitting process, transesterification and soap formation. Also Mike provides a very good starting point for the first batches and the engine goes good enough on the fuel for most climates -- and for most drivers.

But I wasn't always quite happy with my product. Let me explain why: I am a chemistry technician and I did some calculation prior to my first biodiesel batches. I was missing a part of glycerine -- not much, but this was sloppy chemistry for me. I brewed, I weighed, I measured, I read articles, I reread them, I rebrewed and I bought a diesel car to try the

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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Seeds of the world
No seeds, no food
Appropriate technology
What works and fits
Project vehicles
The workhorses

biodiesel out.

Since no one at our Biodiesel discussion group complained about this "missed" glycerine, I thought I must have gone wrong in my calculations and just poured the soup into my "brand new" used Jeep. I started the engine and went for a ride. Engine and pump didn't choke on the stuff, I happily noticed "The Smell" and started cooking some more.

But over time I noticed a slight nailing sound from the engine on fresher mornings and started to research. After a while I stumbled over Camillo Holecek's mail -- you know, the guy with the continuous process -- and this man gave me some good advice.

Theory

Well, if you remember your chemistry class, in many chemical reactions we know of a thing called equilibrium (some reactions go in one direction only). Let's look at a reaction like this:

A+B —> C+D

A+B <— C+D

As you noticed, the reaction direction is reversible, and of this type is also the transesterification reaction we like and do so much. When reactants and products reach equilibrium, the reaction stops. We don't like that, because it means that the WVO isn't converting anymore. Now our biodiesel is a mixture of WVO and FAME (fatty acid methyl ester). You can't tell these two apart, because FAME is a good solvent and thus the unreacted WVO is dissolved. We all know that you shouldn't run a regular diesel engine on unheated WVO, so we have to do something.

The adaptation

There are two remedies for that. Let's imagine that C and D represent our products: FAME and glycerine (A and B stand for WVO and methanol). To push the reaction towards C and D -- meaning, we want to convert all the WVO to FAME -- we can do the following:

1. add more methanol -- this will push the reaction to the right, or
2. retract the undesired product (glycerine) -- right direction again.

Adding methanol doesn't do much, unless you really exaggerate, meaning, you must add more than twice the amount needed to get a slight result. This will make the price of your homemade fuel go sky-high. But, retracting glycerine is another story, as it helps to pull out one third more. This means that more WVO gets transesterificated. Pulling out glycerine during the reaction is hard because you need a liquid-liquid separator (centrifuge) to do that, and this equipment is very expensive. I almost abandoned this idea, when Camillo offered a fine and simple solution: do it

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in two stages!

The process

Let's sum up Mike's process quickly:

- titrate
- heat up the WVO
- prepare the methoxide
- mix WVO and methoxide
- settle and retract glycerine
- wash and dry.

The two-stage process differs in only two things: no titration and a second mix of methoxide and WVO. First things first: why no titration? Well, any analytic chemist will tell you that if you don't work with fresh chemicals and in at least three parallels, you won't get accurate results. So I figured out an empiric quantity of lye (NaOH), which for all my batches was more than good: around 6.25 g of NaOH per liter of waste oil. For the second stage you don't need any new equipment, just some more time. OK, here is how it's done:

CAUTION:
Wear proper chemical-proof gloves, apron, and eye protection and do not inhale any vapors. Methanol can cause blindness and death, and you don't even have to drink it, it's absorbed through the skin. Sodium hydroxide can cause severe burns and death. Together these two chemicals form sodium methoxide. This is an extremely caustic chemical. These are dangerous chemicals -- treat them as such! Always have a hose running when working with them. The workspace must be thoroughly ventilated. No children or pets allowed. See **Safety** for further information.

First stage

1. Measure your WVO and pour it into your reaction vessel

2. Prepare your methoxide this way: mix 25% (by volume of WVO) of pure methanol and (6.25g/liter of WVO) of sodium lye (NaOH)

3. Heat the WVO to 48-52 deg C (118-126 deg F)

4. Add 3/4 of the prepared methoxide (save the rest in a sealed container out of reach of children and flames, sparks... or prepare a fresh batch for the next stage -- do two calculations: first determine the amount of needed chemicals, then split it in 3/4 and 1/4).

5. Mix for 50-60 minutes holding the initial temperature.

6. Let the mixture rest for 12 hours.

7. Separate the glycerine from the FAME -- you'll notice that at this point the glycerine is unusually thin.

Second stage

8. Refill your reaction vessel with the first-stage FAME.

9. Heat the FAME to 48-52 deg C (118-126 deg F).

10. Add the remaining 1/4 methoxide.

11. Mix for 50-60 minutes holding the initial temperature.

12. Let the mixture rest for 12 hours.

13. Separate the glycerine from the FAME -- now the glycerine is a gelatinous mass. On top of the glycerine layer you'll find a thick layer of settled waxes (cream colored), which you shouldn't process further. Remember, this is one of the things that might clog your fuel injectors.

14. Wash and dry with your favorite method. I use the Idaho bubble wash method.

The University of Idaho's Bubble wash method

I would like to explain this method in this article, because it is crucial that your product is washed. Please, do not attempt to drive your vehicle with fuel made on this article's instructions before it's properly washed (the fuel, not the car). This fuel is highly caustic at the end of the second stage and it could damage the high-pressure fuel pump.

Here is what you'll need: a large plastic vessel (twice the volume of your reaction vessel), a cheap aquarium air pump (with enough air flow), a large aquarium air stone and some rubber hose to connect the pump with the stone. I use a pH meter for my measurements, but you can use pH paper (scaled 1/2 pH unit) or a digital pH indicator (around US$15). The pH indicator is the cheapest instrument if you plan to make more than 20 batches.

pH explained

pH has no real unit, as it's formula is "pH= –log (conc. (H+)ions)". So this is a number that is not affected by volume, as chemists needed a way of telling how much H- or H+ ions there are in an unknown volume of a liquid.

The pH of your second-stage FAME will be well over 7 (surplus lye), which is a sort of zero on the pH scale. The scale ranges from 0 to 14, acidic is 0 through 7, from 7 up it shows alkalinity, 7 itself is neutral.

So, if you have, say, 10 litres of a liquid with a pH value of 9 (2 units above 7) and mix it with 10 litres of a liquid with a pH value of 5 (2 units under 7), the result will be a liquid with a pH value of more or less 7, meaning neutral. This trick we'll use to wash our FAME.

The Wash

First measure the pH of your FAME. Be patient, as it takes a little longer than with water mixtures. Write the value down. Prepare your washing vessel; fill it 1/2 with water (or with the same volume as the FAME you want to wash). Make sure that both the water and FAME have roughly the same (room) temperature. Now wash and dry the electrode of your indicator, dip it in the water and add strong vinegar till it reaches as many units under 7 as the FAME's pH is above 7. Mix with a wooden spoon while adding minute amounts of vinegar.

So, if your FAME's pH is 8.7, the water should have a pH of 5.3. All well so far? Now pour your second-stage FAME into the vessel, throw in the aquarium stone and fire up the air pump. Soon you'll notice a string of bubbles rising up through the FAME carrying minute amounts of water right to the surface. When this water falls down again, it washes the soaps and surplus methanol out of the FAME and the vinegar neutralizes the remaining lye.

Let it bubble for 6 hours minimum. Turn the pump off and let the mixture sit for 12 hours. The water will fall to the bottom, turning completely white and the fuel you made will look much lighter in color now. Take the FAME out of the vessel, taking care not to get any water with it. You can achieve that either with a translucent hose, or you can epoxy a valve to your vessel's wall near the bottom. Now slowly heat the washed FAME to 100 deg C (212 deg F) and hold the temperature until you see no more steam bubbles rising. The pH of your homemade fuel will be 7 +/- 0.25, which is good enough. Cool it down, filter the fuel, pour it in your car's tank and drive away.

See **Bubble washing**

Conclusion

I tested biodiesel made by this method thoroughly in my Jeep Cherokee 2.1 liter turbodiesel. It behaves better than "classic" biodiesel, and even better than petrodiesel (the engine is grunting happily). Now that winter is on the doorstep, I will upgrade the fuel filter with a small heater, and that should eliminate other nasty little surprises.

As I'm finishing this article it got cold and it's drizzling outside. I poured myself a finger of fine Scotch whiskey and I'm sipping it slowly. My cat is purring on my lap and I think very much of next spring, looking forward to some traveling. Hopefully we can all meet someday, possibly near a field of blooming sunflowers.

I wish you all good success with your biofuel production.

Aleks Kac
Ljubljana
Slovenija

Special thanks to:

Mike Pelly
Camillo Holecek
Steve Spence
Keith Addison
and Joshua Tickell

All of whom are true gentlemen.

Feedback

I received a number of complaints on the process, namely it seems to be generating a lot of "jelly". GET RID OF THE WATER! A more caustic methoxide in the process will absolutely generate soap in the presence of anything more 1 zillionth % of water. Here is the thing: the lye quantity is not obligatory 6.25 g/liter WVO. With this figure you'll get in trouble if the oil contains any water. For an easier start try 6.00 g/liter of WVO and gradually go up or preheat and dry your oil. More lye means easier ester splitting, less time.

© Aleks Kac 2000

Aleks's two-stage process in **Spanish** -- Proceso de biodiesel en dos etapas:
http://journeytoforever.org/energiaweb/aleks.htm

COMMENT

In one of Aleks Kac's first messages to the Biofuel mailing list he said he was making micro-batches of biodiesel, and the stuff he made from virgin oil was fine, "but with used fryer oil the ester smells like kitten vomit ... it has a real nasty smell, like when you open a compost heap. Any advice?" (It worked okay though.) It didn't take Aleks long to move from novice status to become one of the leading lights in the biofuels movement: it was only five months after this first message that he uploaded his two-stage biodiesel processing method to the Web. Good going Aleks -- keep up the great work!

-- Keith Addison

Mike Pelly

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http://www.green-trust.org/

Joshua Tickell:
VeggieVan
http://www.veggievan.org/

Camillo Holecek of ENERGEA -- Email: camillo.holecek@donauwind.at
http://www.energea.at/en_info.html

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The FOOLPROOF way to make biodiesel

By Aleks Kac

Free fatty acid to ester conversion

NOTE: The two-stage biodiesel processes are advanced methods, **not for novices** -- learn the basics thoroughly first. The single-stage base method is the place to start. **Start here**.

This is a FOOLPROOF way to make biodiesel. No titration is required, and no extra equipment or special equipment -- a thermometer's handy, but NO pH meter!

This is a two-stage procedure, acid first-stage, base second-stage. It is based on the highest free fatty acid (FFA) content found in used cooking oil, but it can be used with any waste vegetable/animal oil or fat, whether or not it has a high FFA content. The process increases yields dramatically. Use it as your standard method.

The **Foolproof Method** has been used to make many thousands of gallons of high-quality biodiesel from all sorts of feedstock. Many individual biofuellers have adopted it as their standard method.

In two professional biodiesel fuel analyses, two years apart, home-brewed biodiesel made by this method met the German DIN 51606 biodiesel standards. This means the fuel is suitable for warranty repair by VW for all their vehicles made from 1996 till today. You can make DIN and ASTM-compliant fuel just by carefully following the instructions. See National standards for biodiesel

Introduction

To make biodiesel fuel efficiently from used vegetable oils and animal fats we have to avoid one major problem: soap formation. Soap is formed during base-catalyzed transesterification (using lye) when sodium ions combine with free fatty acids present in used (and some virgin) vegetable oils and animal fats. The soaps diminish the yield because they bond the methyl esters to water.

Food or fuel?
Straight vegetable oil as diesel fuel

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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Sun power saves lives and trees
Trees, soil and water
Healthcare for mountains

The bonded esters get washed out at the washing stage but make water separation more difficult and increase water consumption. This process takes care of the free fatty acids.

In one early test I used a mixture of 50% heavily used cooking oil and 50% pork lard. The result was a pure product with absolutely no trace of soap! The biodiesel looked nice, and smelt nice, as if made from virgin oil.

This is a simple procedure. The first-stage process is not transesterification, but pure and simple ESTERIFICATION. Esterification is followed by transesterification, but under acid conditions it's much slower than under caustic conditions and it won't do a complete oil-to-methyl ester conversion as the reaction is much more equilibrium-sensitive. Without methanol recovery, the alcohol overdose required would make the price of your fuel jump, and even with recovery it would still be much more expensive. Hence the second base-stage.

Aleks (background) and friend Matevz making biodiesel in Matevz's living room.

For the first stage you'll form a compound out of an acid and an alcohol. The alcohol is still methanol, but instead of using lye (sodium hydroxide), the CATALYST in this reaction is sulfuric acid ("battery acid"). It needs 95% sulfuric acid (battery acid is around 50%). Sulfuric acid is one of the commonest chemicals on Earth, just like lye. More concentrated sulfuric acid -- 98% and above -- costs more, but 95% works just fine if you follow these directions. Other acids won't work: it must be sulfuric acid. The second stage uses lye, as usual -- but it only uses about half as much as other methods.

The sulfate ion in the sulfuric acid combines with the sodium ion in the lye during the second-stage reaction to form sodium sulfate, which is a water-soluble salt and is removed in the wash. No sulfur remains in the biodiesel fuel product.

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Equipment

You don't need a special processor for the Foolproof method. Generally, a bottom-drained reactor vessel is best, closed on top. Tall, narrow containers work better than wide, shallow ones. Use a circulating pump for mixing rather than a mechanical stirrer. The pump should take the mixture from near the bottom of the reactor and return it via the top, to splash down on the surface. For a 35-litre reactor, a 100-W washing-machine pump will do, along with a 1.5kW washing-machine immersion heater to heat the mixture (get a heater that's coated with stainless steel). You could use a thermostat to control the temperature, but they're expensive: just use a thermometer and switch on the heater as required.

Ordinary iron and steel implements and containers will eventually corrode because of the acid used in this process. However, you can still use the usual 55-gal drum. The proportion of acid used in this process is very low -- you should be able to use an uncoated drum for a year or more before the rust gets out of control. I use a polypropylene plastic reaction vessel. Any plastic that won't deform at 100 deg C (212 deg F) or a bit more is fine. Stainless steel is also fine. Use an immersion heater with plastic containers. With steel containers you can use propane heaters to heat the oil, then switch to an immersion heater before adding the methanol.

Test batches

Whenever you're trying a new method, it's always a good idea to make small test batches of a liter or less first to familiarize yourself with the process before moving on to bigger batches. Most people use kitchen blenders for this -- but don't use it for food again afterwards!

The process

1. Filter the used cooking oil first as usual.

2. For a successful reaction the oil must be free of water. Here are two methods of removing the water content:

(a) Settling the water out: This method saves energy. Heat the oil to 60 deg C (140 deg F), maintain the temperature for 15 minutes and then pour the oil

CAUTION

Sulfuric acid is a DANGEROUS CHEMICAL. Take full safety precautions, wear safety goggles, gloves and apron and eye protection. Have running water nearby. Don't inhale fumes!

If you run out of sulfuric

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Foolproof pictures

Aleks made a couple of mini-batches in glass jars for these photographs -- one batch of heavily used cooking oil and fat, and one of pure fat.

1. 30% fats and 70% oil -- lumps of semi-hard fat remain after water boil-off.

2. Fat-oil mixture after melting.

into a settling tank. Let it settle for at least 24 hours. Make sure you never empty the settling vessel more than 90%.

(b) Boiling the water off:
Less-preferred method as it uses more energy and helps to form more FFAs in the oil. Heat the oil to 100 deg C (212 deg F). As the heat rises water separates out and falls to the bottom -- drain it off to avoid steam explosions. Maintain the temperature until no more steam bubbles rise.

First stage

3. Measure the volume of oil/fats to be processed (preferably in liters).

4. Heat the oil to 35 deg C (95 deg F) -- make sure that all solid fats are melted.

5. Methanol: use only 99%+ pure methanol. Measure out the methanol -- 0.08 liters of methanol for each liter of oil/fats (8% by volume). Add the methanol to the heated oil.

6. Mix for five minutes -- the mixture will become murky because of solvent change (methanol is a polar compound, oil is strongly non-polar; a suspension will form).

7. For each liter of oil/fats add 1 milliliter of 95% sulfuric acid (H2SO4). Use a graduated eyedropper, a graduated syringe or a pipette. TAKE CARE when handling the concentrated sulfuric acid!

8. Mix gently at LOW rpm (don't splash!) while keeping the temperature at 35 deg C. The rotation of your stirrer should not exceed 500 to 600 rpm -- speed is not crucial and splashed oil is a mess to clean.

9. Maintain the temperature at 35 deg C for one hour then stop heating. Continue stirring.

acid NEVER try to make up the required volume with nitric acid. It may form small quantities of nitroG (nitroglycerine) -- even the smallest amount can cause horrible accidents. See: **High Explosives**

Methanol can cause blindness and death, and it is absorbed through the skin. Sodium hydroxide can cause severe burns and death. Together these two chemicals form sodium methoxide. This is an extremely caustic chemical. These are dangerous chemicals -- treat them as such! Always have water running nearby when working with them. The workspace must be thoroughly ventilated. No children or pets allowed. Wear safety goggles, gloves and apron and eye protection. Do not inhale any vapors. See **Safety** for further information.

3. Suspension formation after methanol introduction (note murkiness).

4. End of acid stage (note darker colour).

5. 100% semi-solid fats-melted fats.

6. Change after adding methanol: murky fat (normal -- this is procedure).

10. Stir the unheated mixture for another hour, a total of two hours, then stop mixing. Let the mixture sit for at least eight hours, overnight is better.

11. In the meantime prepare the sodium methoxide: measure 0.12 liter of methanol for each liter of oil/fat (12% by volume) and weigh 3.1 grams (up to 3.5 grams if purity is in doubt) of sodium lye (sodium hydroxide, NaOH) per liter of oil/fat. Mix the lye into the methanol until the lye is completely dissolved.

Sodium methoxide is a DANGEROUS CHEMICAL. Take full safety precautions when working with methanol, lye and sodium methoxide, wear safety goggles, protective gloves and clothing, have running water nearby.

NOTE: This process uses only about half the usual amount of lye as there is less fat left to transesterify. Use 99%+ pure sodium hydroxide lye. After opening the container, close it again as quickly as possible to prevent moisture getting in. Weigh the lye carefully -- using too much will complicate the washing process later.

12. After settling for eight hours, or the next morning, pour half of the prepared methoxide into the unheated mixture and mix for five minutes. This will neutralize the sulfuric acid and boost the base catalysis. If you've used solid fat, it probably solidified during settling -- gently melt the mixture first.

Now you can continue with the normal procedure with the lye as the second stage.

Methoxide the easy way

Mixing lye with methanol creates an exothermic reaction, generating heat. It's nasty stuff and it's not easy to mix -- and it must be thoroughly mixed before you use it, with all the lye dissolved. This is a safe and easy way to do it. The disadvantage is that you have to do it in advance, but that's easily arranged.

Take FULL SAFETY PRECAUTIONS when working with methanol, lye and sodium methoxide!

Use a tough, thick, container made of HDPE (High-density Polyethylene -- usually marked "HDPE" on the bottom, with the international code "2"), with a tight stopper and a screw-on lid. Measure out the methanol into the container. Add the required amount of lye -- if you're doing large quantities, add it bit by bit rather than all at once, give the container

7. First-stage glycerine.

8. Second stage -- finished esters.

9. Second-stage glycerine.

Second stage

This is the base-catalyzed stage.

13. Heat the mixture to 55 deg C and maintain for the whole reaction.

14. Add the second half of the prepared sodium methoxide to the heated mixture and start mixing at the same low speed of not more than 500 to 600 rpm.

TAKE CARE when handling the sodium methoxide -- full safety precautions!

15. Optional: If your reactor allows for it, start draining glycerine by-product from the bottom 20-25 minutes after the start of the base stage. (Pump-mixing works best for this -- with pump or mixer, turn the motor off for a few minutes if necessary to allow the glycerine to settle.) Repeat every 10 minutes -- take care, the glycerine is quite hot and caustic! Set aside -- see step 18.

a swirl in between (replace stopper and lid first). Once it's all added, replace the stopper and the lid, and swirl the mixture about for a few seconds. Then let it stand. Do that a few more times, every few hours or so (at least 4-6 times in all). It will be thoroughly dissolved in 24 hours, or maybe a bit longer.

The proportion of lye to methanol used in making biodiesel is low, particularly with the Foolproof method. If for some reason you're using much higher proportions of lye, then don't do it this way.

16. All users: Take regular samples in a 1" to 1.5" diam. glass container. Watch for a straw yellow color of the ester portion. Glycerine (brown and sticky) will settle at the bottom of the jar. When this color is reached (usually in 1.5-2.5 hours) turn the heat and mixer off. Instead of taking out samples to check the color you could use translucent braided tubing for the pump.

17. Allow to settle for one hour.

18. Optional: For easier washing: Drain off the glycerine. Measure off 25% of the total glycerine (including previously drained glycerine if you followed step 15) and mix with 10 milliliters of 10% phosphoric acid (H3PO4) for each litre of oil/fat processed. The mixing can be done with a wooden spoon in a plastic container. Pour the acidified glycerine back into the reactor and stir for 20 minutes, unheated. Allow to settle for at least six hours and then drain the glycerine fraction completely.

THIS IS IT. During the first stage, free fatty acids were esterified and some triglycerids were transesterified. The base-catalyzed

stage does only transesterification, but it's much quicker and more complete.

Washing

19. Use the bubblewash method, but no need to monitor pH anymore. Just add a little 10% phosphoric acid (H3PO4) to the washing water first, 10 millilitres per gallon, just to be on the safe side -- I don't want ANY lye floating around my fuel pump.

If you are curious about the results of your wash, use ordinary litmus paper, it will tell you the rough pH level (acidity/alkalinity). The end result should be neutral (pH7) or just below neutral.

20. Use one-third the volume of water as the amount of biodiesel to be washed. Make sure both the water and biodiesel are roughly the same (room) temperature. Pour your biodiesel into the vessel with the water, throw in the aquarium stone and start the air pump. Let it bubble for 24 hours minimum. Turn the pump off and let the mixture settle for half an hour. The water will fall to the bottom, turning completely white, and the fuel you made will be much lighter in color now. Drain the water, repeat the procedure two more times. Remove the biodiesel from the vessel, taking care not to get any water with it. (See also **Bubble washing**.)

21. Let the biodiesel stand for about three weeks and use only when it becomes crystal clear; take a sample in a large marmalade jar and wait until it is completely cleared. Put it on your window shelf and enjoy looking at it while it clarifies. (If you want quicker results, heat the biodiesel to 45 deg C, 113 deg F, and let it cool.)

NOTE: A deposit may form in the bottom during settling -- don't let it get in your fuel tank!

Acid-stage questions

A question will probably arise: why not mix the methanol with the sulfuric acid before adding them to the oil/fats? Two major reasons: (a) the reaction between methanol and concentrated H2SO4 is quite violent and it could splash, which doesn't happen if you mix it as described; and (b) dimethyl ether can form. Mixing alcohols with concentrated H2SO4 is a way to dry the alcohols (which is good) and also a way to make di-alcohol ethers, not good: dimethyl ether is a gas, colorless and highly explosive.

Base-stage questions

The second-stage product should be quite murky. This is no problem, as it will wash out.

After the processed oil/fat has turned straw-yellow (step 16), you've let it settle for an hour and drained the glycerine, you should have a total of about 120 ml of glycerine per litre of oil/fat used. If it's less than about 100 ml/litre oil, something's wrong, even if the color is right -- the process hasn't gone far enough.

This will almost certainly be due to carbonated lye. Lye has a really limited shelf life: CO2 from the air neutralizes it and forms sodium carbonate. Carbonated lye is much whiter than pure lye, which is almost translucent. The carbonate in the lye won't harm the reaction, but you'll have to use more lye.

The solution: Repeat the procedure from step 13. Prepare a fresh batch of methoxide with 0.03 liters of methanol and 0.75 grams of lye for each liter of oil/fat. Reheat the biodiesel to 55 deg C, add the fresh methoxide and mix as before. No need this time to remove glycerine during the processing as in step 15, and don't worry about the color. Mix for one hour, settle, drain off the extra glycerine, and proceed from step 18.

If you plan to continue using the carbonated lye, make sure to increase the amount by 25% next time you make biodiesel. Store lye at room temperature, in dry conditions if possible, with the container lid really tightly closed.

Methanol recovery (optional)

To keep costs down, even amateur biodiesel producers try to salvage the unreacted methanol. There are two major methods to do this: heat extraction and vacuum/heat extraction.

Heat extraction

Heat the second-stage product to 70 deg C in a sealed boiler/vessel and lead the fumes into a condenser. Intercept the condensed methanol in a liquid trap. Take great care because methanol is highly flammable and the fumes are explosive. The temperature will need to be increased as the amount of unreacted methanol in the mixture decreases.

Vacuum/heat extraction

This is basically the same as heat extraction, but it requires less

energy. The drawback of this method is that you need a special vessel and equipment to do this. A good example is Dale Scroggins's reactor:
http://home.swbell.net/scrof/Biod_Proc.html

When building your reactor it may be a good idea to take one step at a time. Build the reactor, get confident with the process and eventually upgrade to methanol recovery.

At least a quarter of the methanol used can be recovered -- ie, 50+ ml per litre of oil/fat. Mix it with fresh methanol for preparing the next batch of methoxide.

Quality

Diesel engines require quality fuel. You just can't pour poor-quality biodiesel into the tank and expect the engine to go on and on without problems. You have three very dangerous enemies: free glycerine, poorly converted oils/fats and lye. Free glycerine and mono-, di- and triglycerids (poor ester conversion) will form gum-like deposits around injector tips and valve heads, lye can damage the injector pump. The key to good fuel is to just do it right and finish it! Use pure chemicals (sulfuric acid, sodium lye and methanol) and measure them accurately, and follow the instructions carefully -- this will take care of poor conversion. Proper washing will get rid of the glycerine and neutralize any remaining lye.

There are also kits available for various quality tests. I was told in a letter from one of the visitors to our site of a test used by the motor industry for determination of glycol in motor oil. This should work for free glycerine determination.

"For glycerine analysis I suggest that you get a test kit for determining ethylene glycol in motor oil. This test is simple and it generates a purple colour if substantial free glycerol is present. Just analyze the biodiesel as if it were motor oil. Used-car dealers use the test to determine if there are leaks in the cooling system. Glycol and glycerol give the same result in the test." (With thanks to Martin Reaney)

Paper chromatography and thin layer chromatography will tell you the conversion rate, and titration may tell you about any remaining lye.

(See also **Biodiesel and your vehicle**.)

Aleks Kac
Ljubljana
Slovenija

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Ian's vacuum biodiesel processor
Chuck Ranum's biodiesel processor
Micro-Production System for Biodiesel
833 Gallon Per Day Batch Plant
The $150 "Appleseed" Fumeless Processor
How to make a cone-bottomed processor
Biodiesel technology

We don't recommend buying the cone-bottomed plastic biodiesel processors on sale at quite a few websites. They're expensive, most of them don't work very well, some of them have been prone to catching fire, most of them are not properly sealed, and they can't withstand much pressure, which is something that might happen. Also, some of these vendors end up by bending the process to fit the processor -- doing full justice to the process would mean they'd be too expensive. So they claim that washing isn't necessary, for instance, rather than providing a separate washing tank (using the same tank for processing and washing isn't efficient). Some don't even provide for proper heating! In many cases you'd end up paying a lot of money for a processor that will not make high-quality fuel. You can make a better processor yourself, for much less money. It's not difficult, there are plans, designs and ideas here to help you. There's also good advice to be had from experienced users at the **Biofuel mailing list**.

Hazards

The main hazards of making biodiesel are poisonous fumes, dangerous chemicals, and fires. See **Safety** for the first two. Here we'll deal with fires. There have been several fires, one operator

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lost all his equipment, his shed, and was slightly burned. But don't be put off, it's easy to avoid fires. Most important, use closed, fumeless processors. Preferably they should be able to withstand some pressure.

Good advice from **Todd Swearingen** of Appal Energy:

The main fire hazard is using an open reactor and poor ventilation in the presence of an ignition source.

Ignition sources can be:

- Using combustible fuels as a direct heat source (propane, natural gas, wvo, wood, etc.), rather than a heat exchange system where the flame is far removed from the processing area.
- Open electric motor housings, rather than TEFC motors (Totally Enclosed Fan Cooled AC Motors) or explosion proof motors.
- Disconnecting an electrical appliance by pulling out the wall plug, rather than using enclosed switches.
- Any open flame.

Other fire sources can be over taxed pumps and motors in close proximity to combustible materials (garage walls, plastic barrels, almost anything), oversized breakers and/or fuses, undersized wiring (such as 14/2 Romex) for higher amperage draws. And there always is the danger of spontaneous combustion in the presence of oily rags, especially when working with drying oils such as hemp and linseed. This threat decreases as the saturation of the oil/fat increases. (See Iodine values)

Maria Alovert ("Girl Mark") adds:

Don't rely on a fan or ventillation system for fume control -- just DO NOT produce fumes in the first place. Use a sealed processor. Use a sealed processor. Use a sealed processor.

Another fire danger, not specific to biodiesel, is the use of very long extension cords and drawing a high power draw on them. Sometimes you'll be in this position in order to work in a shed or space outdoors without proper wiring. You need at least a 12 -gauge extension cord to run an electrically-heated processor, and if the cord is over something like 100 feet you want something bigger (10-gauge cord). You should not run both your heater and your pump at the same time on one circuit in this situaion (many pumps I've used are something like an 8-amp draw, and the heater

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is about 10 amps). A long cord can burn up with a high load long before your circuit breaker knows anything's wrong. This applies to any sort of electrical heating or high power draw.

Again, most of these potential dangers of fire or explosion are absolutely minimised if you use a sealed system and don't create any explosive/toxic atmospheres in the work area in the first place. This is EASY to achieve (fumeless equipment that is).

K.I.S.S. processor

A thousand gallons of fuel a year is more than enough for most people. That's about 20 gallons a week. Homebrewers say their biodiesel costs them about 60 cents US a gallon or less, so in that first year you'll save at least a thousand dollars, or much more if you live almost anywhere but the US. No need to spend it all on a processor though -- a K.I.S.S. processor (Keep It Simple, Stupid) is all you need. Here's one way:

"The easiest and least expensive processor setup for 15-20 gallon batches would be a steel drum WVO collector/separator and a steel drum reactor, with reclaimed motors and stirring attachments 'duct-taped' together. Methoxide mixed in a 5-gallon HDPE carboy (see **Methoxide the easy way**). A glycerin drain on the reactor drum. Wash in a 55-gallon drum.

"Use either an immersion heater at the bottom of the reactor and WVO collector (for dewatering the oil) or plumb in a recirculating pump from your household hotwater tank. A little submersible pump like the **Little Giant Pump** at Surplus Center: http://www.surpluscenter.com/item.asp?UID=2003050414093431&catname=water&qty=1&item=2-1225 can be fitted with fluid-tight conduit to the electrical inlet and flexible hose to the pump ports, making it transferable from one application to another, pumping glycerin, water or biodiesel. This way you can get away with only one pump, rather than having a separate pump for each tank.

"Such a system would get you through years of personal use with the least amount of headache and the least amount of cost. If you ever upgraded, you'd just expand on the system as you've made it work for you."

-- Todd Swearingen, Appal Energy

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Homepage
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Handmade Projects
Ichijima
Japan

Mike Pelly's new processor

Mike and the Pelly Model 'A' processor: Mike's holding the processor's pick-up hose in his left hand, for pulling grease into the system from the dewatering pot, and the hose used for pumping finished product into the vehicle's fuel tank in his right hand.

Mike Pelly is one of the mainstays of the burgeoning biodiesel movement. He's been making biodiesel and teaching other people to make it for a long time. Thousands of people all over the world are making biodiesel after reading Mike's method at our website.

A lot of thinking and a lot of good ideas have gone into his new processor. This

is the second prototype of the Pelly Model 'A' processor, a fully operational prototype that produces good biodiesel.

There'll be a third prototype, incorporating some improvements as well as feedback from other experienced biodiesellers who've seen the processor and made suggestions. And then Mike will start producing the processors for sale.

In the meantime, if you're interested, drop Mike a line.
Mike Pelly <renewablenergies@yahoo.com>

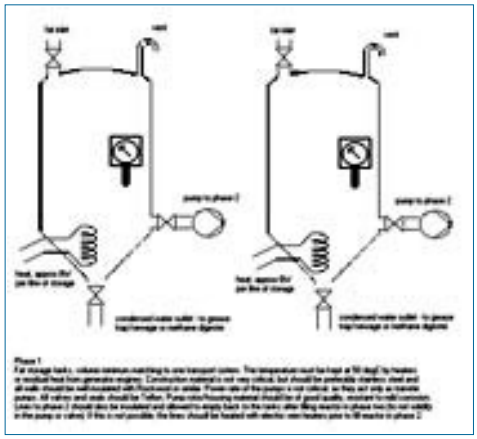
'Foolproof' processors

Aleks Kac (left) and friend Matevz with Matevz's beautiful round-bottomed stainless steel processor, built for the Foolproof method.

Bulk processor outline for "Foolproof" process

Applicable for almost any size

By Aleks Kac



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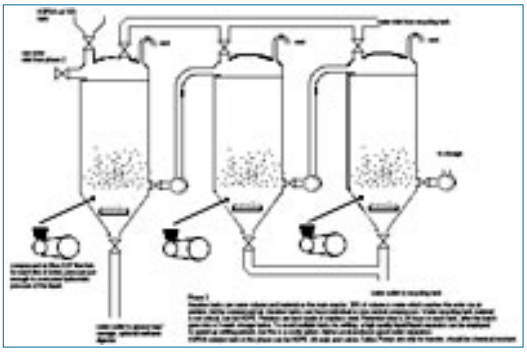
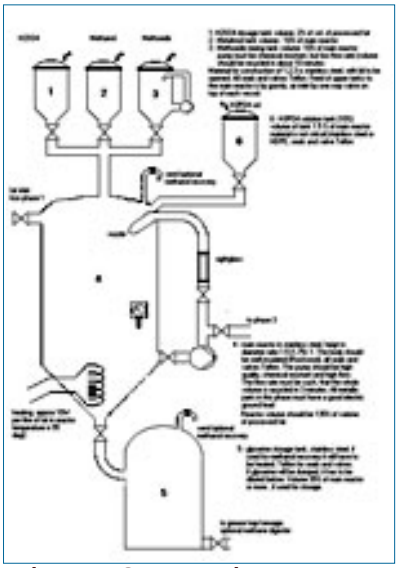
Phase 1 -- primary settling





Phase 2 -- main reactor

Phase 3 -- washing processor

Touchless processor

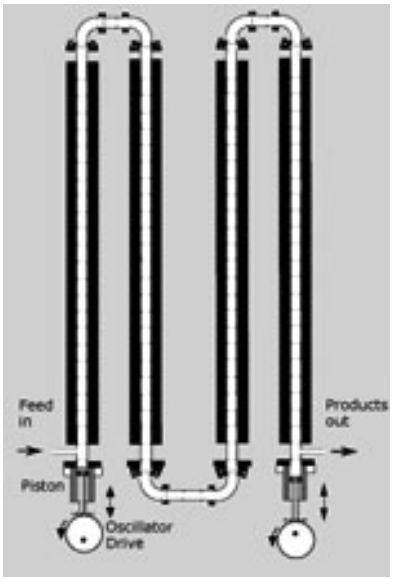
Dale Scroggins's processor is "a 100-liter processor made from mostly salvaged materials that almost fills itself, mixes everything, recovers the unused methanol, washes and dries the ester pretty much by flipping a few switches... I first evacuate the tank, then suck in the oil through a filter setup that I'm a little too proud of. I mix the methoxide separately, using a drill press with a paint mixer installed, then suck it into the tank. Then flip the pump switch. Watch through the clear hoses and marvel. Later, flip off the pump switch, check for separation, flip on the vacuum pump (which is connected to a liquid trap which is connected to the condenser which is connected to the tank) and watch the excess methanol collect in the trap. When no more collects, I open the

tank to the atmosphere and drain off the glycerine. Then suck in water and begin the wash." (From a message to the **Biofuel mailing list**, 11 Jan 2001)

Full description, more photos and drawings at Dale's website: http://home.swbell.net/scrof/Biod_Proc.html

---

Make your own continuous reactor! Oscillatory Flow Mixing (OFM) provides highly effective mixing in tube reactors by the combination of fluid oscillations and baffle inserts ... OFM is particularly suited to continuous processing. How it works, Research, Technology, Publications, and more, with diagrams and photographs.
http://www.cheng.cam.ac.uk/groups/polymer/OFM_page.html



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Biodiesel news articles published in Hong Kong (Click on the image to read the full text.)

Ming Pao
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Special Report
炸彈條食油煉環保汽油
陸恭蕙：環署不積極引入新技術

Apple Daily
June 27, 1999
日蘋果報
燒靚油減巴士黑煙7%
環保社擴大測試至的士貨車

Standard
HK Standard
June 27, 1999
Fat-burning may cut bus engine pollution

Biodiesel in Hong Kong

One of our aims in making biodiesel was to propose a solution that could help improve Hong Kong's galloping air-pollution problem.

Hong Kong is choking on air-pollution. It drives people away, it drives business away, and it drives tourists away. It costs the city billions of dollars. The Government says it kills about 2,000 people a year. And it's getting worse all the time.

"Government studies confirm that the annual health costs associated with air pollution are equivalent to some half a percent of Hong Kong's GDP, that is, $5.5 billion at 1996 figures." -- Legislator Christine Loh, Citizens Party, RTHK, 2 May 1999

"A container truck driver died from carbon monoxide poisoning after being stuck in a traffic jam, a coroner concluded yesterday." -- South China Morning Post, April 1999

"Air pollution will worsen before it starts to improve, Environmental Protection Department director Robert Law warned yesterday." -- South China Morning Post, 25 March 1999

On "bad" days (not that there are "good" days) the government warns the old and the ill to stay indoors.

It's a complex issue, and there are constant furious debates about it. About the only thing everyone agrees on is that the main culprit is the exhaust smoke from diesel engines. But all plans to scrap the diesels have so far been scuttled by the transport lobby.

Hong Kong's transport industry, like transport industries everywhere, uses diesel engines, because they're cheap, tough, efficient, economical and reliable -- diesels last 10 times longer than petrol engines. Most people travel by diesel every day, virtually all goods are moved by diesels. Scrapping diesels would raise the costs of everything, making everyone's life tougher.

"'You can replace diesel taxis and minibuses but the

明報 Ming Pao
June 27, 1999
九巴擬試用生化柴油

Sing Tao
星島日報
June 27, 1999
九巴：生化柴油有助環保
測試成效令人滿意

Hong Kong Economic Times
經濟日報
July 5, 1999
20輛小巴 10月試用生化柴油
商會與環保機構合作 原料來自食肆

remaining diesel problem has to do with vehicles that drive our economy,' an official said." -- Hong Kong Standard, 4 October 1999

There are about 135,000 of these "economic" diesels, accounting for nearly 70 per cent of the total road distance travelled in Hong Kong. Biodiesel could help provide an immediate solution.

"Why not just improve the existing diesel fuel and reduce its particulates?" -- Legislator Selina Chow, February 2 1996

"The Transport Department and the Environmental Protection Department should be working together to pilot new fuels and technologies that may be economically viable now or in a few years' time" -- Legislator Christine Loh, September 24 1998

So, when we brewed up some biodiesel out of waste cooking oil, the press got interested.

Biodiesel in the news

Keith Addison with Handmade biodiesel.

"Environmentally clean fuel from used French fry oil," said the News Focus headline in Ming Pao Daily on 30 April 1999.

"Who would have thought that you could turn McDonald's French-fry used cooking oil into environment-friendly diesel fuel in your kitchen and run your car on it?" the paper asked, describing how we'd done it and why.

But it also reported that the Environmental Protection Department had said biodiesel "could increase emissions of Nitrogen Oxides" (NOx) and had therefore rejected it for Hong Kong.

We said they were wrong, and quoted published research that showed NOx levels could be reduced below ordinary diesel levels simply by adjusting the engine timing.

And environmentalist legislator Christine Loh, who has strong views on air-pollution, attacked the EPD, calling them "shortsighted" and "unfair".

Not wanting to get involved in a political row, we backed off,

South China Morning Post
COMMENT
LETTERS TO THE EDITOR
Don't allow biodiesel opportunity to slip away

South China Morning Post
COMMENT
So negative

South China Morning Post
COMMENT
LETTERS TO THE EDITOR
Interested in biodiesel as renewable energy

and in some confusion.

"The EPD recently toughened emissions controls to bring Hong Kong into line with European and US standards." -- South China Morning Post, 29 January 1999

"Like most European countries, we will be adopting the more stringent Euro III emission standard as from 2001." -- 1999 Policy Address, Tung Chee-hwa, Chief Executive of the Hong Kong Special Administrative Region (SAR), 6 October 1999

But both Europe and the US use millions of gallons of biodiesel every year. Both are *expanding* their diesel fleets in a bid to cut greenhouse gas emissions, in line with the Kyoto Protocol.

"So important is biodiesel as a low-cost, immediate solution to diesel emission problems that the US Congress has passed biodiesel legislation to foster public acceptance and industry use of this new alternative vehicle fuel." -- US biodiesel producer Southern States Power, news release, 30 March 1999

Yet Hong Kong bans it, on the grounds of NOx emissions, though dozens of scientific studies by major instititions show that NOx emissions with biodiesel are easily reduced to well below conventional diesel levels, without sacrificing the considerable reductions in particulate matter (PM) emissions with biodiesel, which are a far worse pollutant anyway.

"We've done all the things on vehicle pollution and control of dust emissions that they've done in Europe. We have the toughest standards in Asia. But while Europe has seen dramatic improvements, we haven't." -- Tse Chin-wan, Assistant Director, EPD, Postmagazine, 24 January 1999

Maybe we're not alone in our confusion.

Progress?

A couple of weeks later the Ming Pao reporter called us to say the EPD spokesman had told him they'd decided to reverse their decision to reject biodiesel as a way to fight air-pollution, because we'd shown that it could be made by recycling a waste product (used cooking oil), giving it a dual purpose.

The EPD still had reservations about the level of nitrogen oxide emissions with biodiesel, the spokesman said, but the department

South China Morning Post
COMMENT
LETTERS TO THE EDITOR
Government's LPG policy offers no solutions

South China Morning Post
September 28, 1999
Minibus takes landmark trip on sunflower power

now had an open mind on biodiesel and would make further investigations.

Christine Loh later confirmed to us that the EPD had changed their stance. "They just needed to get prodded on the NOx bit," she said.

Good enough. We knew other people were working on making biodiesel available in Hong Kong, we'd brought the issue to the public eye and helped open the door, so we left them to it and got on with other work.

Good news -- and bad

"KMB tests biodiesel -- made from BBQ pork fat, it can decrease black smoke by 7%," read a Ming Pao headline on 27 June. Most of the big papers carried the story.

KMB engineering manager Shum Yuet-hung at the biodiesel press conference.

In cooperation with a group called Better Environment Hong Kong (BEHK), KMB (Kowloon Motor Bus), Hong Kong's biggest franchised bus company, much criticized for belching black smoke, had tested weak blends of 10 to 15% biodiesel with ordinary diesel fuel in a bench-mounted Cummins LT10 diesel engine from one of its buses, and called the press to witness it.

Good news! But what was all this stuff they were saying about nitrogen oxide emissions?

BEHK member Dr Dennis Leung Yiu-cheong, an associate professor at the University of Hong Kong Department of Mechanical Engineering, said: "For the tests we conducted on biodiesel, we used waste animal fats from restaurants as they release less nitrogen dioxide than vegetable fats" (Hong Kong Standard).

He also said animal-fat biodiesel decreases pollutant particles compared with biodiesel made from vegetable oil (Sing Tao), and that "in Europe and the US, where the temperature is moderate, mostly vegetable oil is used for biodiesel. He said because Hong Kong's weather is warmer, animal fat, which doen't contain sulphur, does not solidify, so it can be used to make more

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environmentally friendly biodiesel" (Apple Daily).

So now we have "environmentally friendly biodiesel" from animal fats and, what, environmentally unfriendly biodiesel from vegetable oil, depending on the weather? Who are these guys? (They're a group of local academics and others, apparently supported by Mobil Oil.)

And Ming Pao reported: "The EPD has reserved judgment because biodiesel could increase Nitrogen Oxides in the exhaust compared with ordinary diesel."

Whatever happened to their change of mind?

The Hong Kong Economic Times did a follow-up story the following week: "An EPD spokesman said: 'Using biodiesel as a fuel for vehicles could increase Nitrogen Oxide (NOx) emissions in exhaust gas. NOx is already high in Hong Kong's Air Pollution Index, so using biodiesel will not improve Hong Kong's air pollution problem.'"

The story also reported BEHK chairman Steve Choi Sau-yim saying: "The key is in the materials used. If animal fats are used to make biodiesel, it can cut NOx in the exhaust to about 5 to 10% less than petro diesel, while plant oil biodiesel increases it by 15%. If you choose the material (the origin of the cooking oil) carefully, it's not difficult to solve the NOx problem."

Non-issues

This might fit in nicely with the EPD's singular view of biodiesel, but it's wrong, and ruling out used vegetable oil as a source material is not helpful.

Some studies have indeed shown lower NOx emissions with animal-fat biodiesel than with virgin vegetable oils, because fats have different combustion characteristics.

But recycled oils and palm oils have similar profiles to fats -- there's no difference between NOx emissions from animal-fat biodiesel and biodiesel made from used vegetable cooking oils or from palm oil.

Anyway, whatever it's made of, NOx emissions with biodiesel are a non-issue: "Biodiesel NOx emissions can be effectively managed and efficiently eliminated as a concern of the fuel's

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Silkworms in a shoebox

use," says the US National Biodiesel Board, along with everybody else except Hong Kong's EPD.

Action

The whole promising biodiesel initiative in Hong Kong was being derailed, for no good reason we could see.

So we wrote a letter to the Editor of the South China Morning Post. It was published as the main letter on 20 July ("Don't allow biodiesel opportunity to slip away"), and it sparked a chain of responses, first in support, and then another main letter, a schoolmarmish rebuttal by W.C. Mok of the EPD ("Interested in biodiesel as renewable energy"), baffling in its opacity and denial, totally rejecting biodiesel in favour of the EPD's plans to convert Hong Kong's 18,000 diesel taxis to Liquid Petroleum Gas (LPG).

There are serious objections to the LPG plan and severe obstacles to its being implemented, and even if it is implemented the effect is expected to be minimal:

"Perhaps you think that the API (Air Pollution Index) readings are going to zoom dramatically downwards if LPG is introduced. They will not," said the South China Morning Post (24 January 1999). "That could turn out to be a major public relations disaster."

Reaction

We received several emails from parties interested in biodiesel, furious at Mr Mok's response:

"It is very disappointing to read today in the South China Morning Post the answer to your article from Mr. Mok..."

"Mr. Mok should know that there are dozens if not hundreds of cities that use biodiesel just for the air quality in their city..."

"There is 20 years' experience of biodiesel..."

We posted Mr. Mok's letter on the Internet bulletin board run by the US National Biodiesel Board, without comment. This drew some interesting responses:

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"I read this letter and can't help feeling that Mok is the public relations/damage control for the oil companies..." (Message)

"I am surprised to find someone like Mr. Mok who still can maintain his biased position for LPG. Not too many people talk about LPG as an alternative green fuel any more..."

"President Clinton just passed an 'Executive Order' on August 12 to 'promote Biodiesel use to meet environmental challenges'. This is news for Mr. Mok..."

Two weeks later the South China Morning Post published yet another main letter on biodiesel, from engineer and entrepreneur Paul Tarrant, who demolished Mr Mok's arguments with great authority ("Government's LPG policy offers no solutions").

Good enough to drink

...and he drank it!

But Mr. Mok was unfazed. On 28 September the South China Morning Post carried a front-page story of another biodiesel test, featuring a minibus in a 10-kilometre on-road test of sunflower oil biodiesel from Germany, conducted by Sunland.

It took Sunland 18 months and "many letters" to get permission for the test. Such caution -- when more than 60% of the diesel fuel used in Hong Kong is smuggled in from China and sold at half-price or less, poor-quality, dirty stuff containing 10 times as much sulphur as legal diesel fuel.

The story quoted Mr. Mok denigrating biodiesel in favour of LPG: "Bio-diesel increased nitrogen dioxide emissions, Mr Mok said."

This didn't bother the minibus driver. The original Ming Pao story on biodiesel showed Keith holding up two glasses of biodiesel; Apple Daily followed suit, showing KMB's engineering manager holding up two glasses of biodiesel. Now driver Choi Hang-wan also had a glass of biodiesel -- and he drank it!

"It tastes fine," he said.

The road ahead

In his 1999 Policy Address in October, Tung Chee-hwa, Hong Kong's Chief Executive, outlined his plan to clean up Hong Kong's filthy air.

It included LPG for taxis and minibuses, particulate traps, catalytic converters, $1.4 billion in grants for the conversions, phase-outs of old diesels, tougher standards, tougher action against smoky vehicles, tougher action on smuggled diesel fuel, pedestrianization schemes, electric vehicles, more use of rail services.

It didn't include anything that could bring an immediate improvement, such as biodiesel.

"**WHILE** Hong Kong fiddles, biodiesel will burn in the vehicle of two intrepid explorers from Lantau Island on their way overland to South Africa. Keith Addison and Midori Hiraga will brew the stuff as they travel on a 2-year expedition through China and Africa studying and reporting on environmental conditions. By the time they get there, perhaps Hong Kong will have made up its mind on biodiesel."
-- Lisa Hopkinson, October 31, 1999, Clear the Air (Hong Kong)
http://www3.cleartheair.org.hk/biodiesel.htm

LPG health risks

"LPG 'could be worse for health than diesel'." -- South China Morning Post, 23 August, 2000.

The article said: "Switching vehicles from diesel to liquefied petroleum gas might pose health risks, research carried out at America's Harvard University suggests."

The study, by the Harvard Center for Risk Analysis (HCRA) at Harvard School of Public Health, found, among other things, that natural gas (LPG) reduces emissions of fine particulates, those smaller than 2.5 microns, but may generate more ultrafine particles than diesel, of less than 0.1 micron.

"Several studies indicate that ultrafine particles may have an even more dramatic impact on health than those in the fine category."

It also found that LPG would increase greenhouse gas emissions, of C02, and of methane, which "is approximately 20 times more potent as a greenhouse gas than CO2".

"European regulators seem to be favoring diesel fuel as part of their effort to comply with the Kyoto agreements to stabilize CO2 and other greenhouse gas emissions," the report said. "They are using tax incentives and emissions standards to encourage the use of new cleaner-burning diesel fuels. European vehicle manufacturers appear to be increasing their application of 'green' diesel technology that captures significant amounts of particulates."

Harvard press release:
http://www.hsph.harvard.edu/press/releases/press1102000.html

Complete copy of the report (PDF, 205 KB):
http://www.hsph.harvard.edu/Organizations/hcra/diesel/diesel.pdf

Biodiesel in Taiwan

With the support of the US National Biodiesel Board, the Taiwan chapter of the American Soybean Association (ASA) has completed the dossiers for registration of soy-based biodiesel on the clean fuel list. Road tests will start in September. A local bus fleet that will provide six buses for the road tests. Each bus will run on its regular route for two and a half months to generate data. If soy-based biodiesel is approved, ASA will work with the government of Taiwan to develop mandates and incentive programs to encourage the use of soy-based biodiesel.
-- Biodiesel Bulletin, National Biodiesel Board, September 1, 2000
http://www.biodiesel.org/bio_bulletins/82000bdbulletin.htm

Biofuels

Biofuels Library
Biofuels supplies and suppliers

Biodiesel

Make your own biodiesel
Mike Pelly's recipe
Two-stage biodiesel process
FOOLPROOF biodiesel process

Biodiesel processors
Biodiesel in Hong Kong
Nitrogen Oxide emissions
Glycerine
Biodiesel resources on the Web
Do diesels have a future?
Vegetable oil yields and characteristics
Bubble washing
Biodiesel and your vehicle
Food or fuel?
Straight vegetable oil as diesel fuel

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Environmentally clean fuel from used French fry oil

Ming Pao
明報
Special Report
炸薯條食油煉環保汽油
陸恭蕙：環署不積極引入新技術

Ming Pao News focus
Friday 30-4-1999
By Chan Chi Wai

Who would have thought that you could turn McDonald's French-fry used cooking oil into environment-friendly diesel fuel in your kitchen and run your car on it?

This is not just a dream, but with some courage, environmental awareness, and help from other knowledgeable people on the Internet, foreigner Keith Addison last week finally succeeded in making "biodiesel". He believes he is the first person to make it in Hong Kong.

He has lived in Hong Kong over 10 years, and saw that even in Lantau Island, air pollution is getting worse and worse in recent years. This is one reason why he is trying to promote biodiesel use in Hong Kong.

Talking cheerfully, he took a glass of clear gold "biodiesel" fuel and let the reporter smell it. The reporter smelled a slight fragrance, and could hardly believe this could be used as fuel to run a car.

Internet friends' help

It was not that easy. After obtaining the know-how on the Internet, Addison first went to McDonald's and asked for some used cooking oil. Then, in the kitchen, he "transesterified" it, carefully mixed poisonous methanol and lye, and proceeded with the chemical reaction. Although he was confident it would work, he and his partner were surprised when they succeeded.

Why is he taking such trouble to make environmental diesel fuel? He was planning an "Environmental Journey", driving 4WDs across Asia and Africa this summer, but using polluting diesel for the vehicles was not suitable, so he looked for a better solution on the Internet.

Even on Lantau, the air is dirty

He said the most important aim of making "biodiesel" is to raise the environmental awareness of the government. He showed great regret that, even in Lantau, the air is dirty and often hazy, while Hong Kong's air pollution problem has reached unacceptable levels.

According to a Transport Department report, Hong Kong has 150,000 diesel-engined vehicles. Although the Environment Protection Department (EPD) and the government have been testing LPG-engined taxis, and 18,000 taxis will change to LPG after so many years later, still 130,000 heavy vehicles are using diesel fuel and causing air pollution problems, and this is still not solved.

Addison pointed out that "biodiesel" can be used in all diesel engined vehicles, with no need for modification, not only decreasing the air pollution, but also adding no extra expense for taxis or truck drivers.

sidebar:

Christine Loh: EPD is being shortsighted over this new technology

Other countries have already developed the use of vegetable oil to make environmentally friendly "biodiesel" for a long time, greatly decreasing the amount of black smoke and hazardous exhaust fumes by 40 to 60 per cent.

However, Hong Kong's Environmental Protection Department says that biodiesel "could increase emissions of Nitrogen Oxides" and for this reason, has rejected introducing this kind of environmental diesel fuel, although it is used in USA, Germany, and other countries.

Christine Loh of the Citizens' Party, which she said had investigated "biodiesel", criticized the EPD for being shortsighted in not introducing this kind of new environmental technology. She pointed out that from other countries' experience, biodiesel exhaust is cleaner than ordinary diesel (no Sulphur Dioxide or lead), and produces much less black smoke and other pollutants compared to ordinary diesel.

Rejecting environmental diesel

She said the EPD totally rejecting biodiesel because "Nitrogen Oxide emissions could increase, thus polluting the air" is not fair.

Environmentalist Addison said the EPD's objection could be based on mistaken data. According to Professor Kerr Walker, a British specialist on biodiesel, in a 1994 study, vehicle operators need only adjust the diesel engine's injection timing and decrease the engine running temperature, and the amount of Nitrogen Oxide in biodiesel emissions could be decreased to below the level of ordinary diesel fuel.

Table:

Biodiesel exhaust emissions vs petrodiesel

Sulphur dioxide - nil

Lead - nil
Black smoke - 40-60% less
Carbon monoxide - 20-60% less
Nitrogen oxide - about the same

BBQ oil reduces bus black smoke by 7%
Better Environment Hong Kong wants to expand it's test to taxis and trucks

Apple Daily
June 27, 1999
日蘋報果
本港新聞
燒臘油減巴士黑煙7%
環保社擴大測試至的士貨車

Apple Daily
Sunday 27th June 1999

Better Environment Hong Kong (BEHK) and KMB (Kowloon Motor Bus) tested biodiesel fuel, and found that mixing ordinary diesel fuel with biodiesel made of BBQ oil collected from restaurants reduced bus engine black smoke by 7% without losing any power.

BEHK plans to conduct a six-month road test from mid-August of 60 buses, minibuses, taxis and trucks, and hopes to convince the government to help introduce environmentally clean biodiesel to Hong Kong and reduce black smoke pollution.

BEHK spokesman Choi Sau-yim said if the group succeeded, it could help food industries collect used fry oil and BBQ oil, reduce the cost of dirty used oil disposal, and have a beneficial environmental effect.

BEHK requests study budget of $600,000

Mr. Choi said the group plans to produce a full report by next March, and will lobby the government and the Legislative Council to introduce biodiesel technology in Hong Kong. The estimated cost of the investigation is about $600,000.

KMB engineering manager Shum Yuet-hung was satisfied with the initial test results, and said he was willing to go ahead with the second-stage road tests with the cooperation of BEHK.

BEHK member Dr Dennis Leung Yiu-cheong, an associate professor at the University of Hong Kong Department of Mechanical Engineering, said that in Europe and the US, where the temperature is moderate, mostly vegetable oil is used for

biodiesel. He said because Hong Kong's weather is warmer, animal fat, which doen't contain sulphur, does not solidify, so it can be used to make more environmentally friendly biodiesel.

Test results:

% of biodiesel: 0%: 10%: 15%

Engine power (ton/meter): 993: 993: 998
Engine Power (horse power): 239: 235: 238
Fuel economy: 0.229: 0.236: 0.233
Black smoke amount: 38.5: 36.7: 35.8

Restaurants help research on moves to reduce emission levels Fat-burning may cut bus engine pollution

Standard HK Standard June 27, 1999
Fat-burning may cut bus engine pollution

Hong Kong Standard
27 June 1999

"Buses using biodiesel would not have their engine output torque and engine output power seriously affected."

MIXING a fuel made from animal fats with conventional diesel could reduce emission of smoke and pollutants by vehicles, according to tests carried out by Kowloon Motor Bus (KMB).

At the same time, engine power can be maintained at a satisfactory level, proving that the product, biodiesel, aids environmental protection.

"Bio-diesel is produced from waste-animal fats, which help fully utilize natural resources. Besides, it can help lower the smoke level as well," KMB engineering manager Shum Yuet-hung said yesterday.

"Buses using biodiesel would not have their engine output torque and engine output power seriously affected."

He said bus engine parts did not have to be changed to use biodiesel.

University of Hong Kong Department of Mechanical Engineering associate professor

Dennis Leung Yiu-cheong said: "For the tests we conducted on biodiesel, we used waste-animal fats from restaurants as they release less nitrogen dioxide than vegetable fats."

A biodiesel test was carried out by Better Environment Hong Kong (BEHK) about six months ago.

BEHK director Steve Choi Sau-yim said: "More tests will be carried out on blending different proportional contents of biodiesel in conventional diesel fuel, which aims to find out the best combination."

More tests are planned but KMB refused to say when vehicles would use biodiesel.

Caption:
Fat chance: KMB engineering manager, Shum Yuet-hung conducts a biodiesel engine test yesterday. PICTURE BY LO PUI-KWAN

KMB tests biodiesel Made from BBQ pork fat, it can decrease black smoke by 7%

明報 Ming Pao
June 27, 1999
九巴擬試用生化柴油

Ming Pao
Sunday 27th June, 1999

Although the Environmental Protection Department (EPD) has a negative attitude to this possibility of reducing black, dirty polluting diesel exhaust, KMB (Kowloon Motor Bus) yesterday conducted an initial test of biodiesel, using biodiesel fuel additive made from used cooking fat from grilling pork, with the result that black smoke was reduced by 7%.

Encouraged by the test result, KMB is considering using this biodiesel made of recycled waste in road tests, to decrease air pollution. KMB is the first public company introducing biodiesel.

Satisfied with the test

However, KMB engineering manager Shum Yuet-hung admitted that he could not say what effect adding biodiesel to ordinary diesel fuel will have on ticket prices. But he said it would be worth it considering the environmental improvement.

Biodiesel is made of plant oils or animal fat, not fossil fuel. It not only reduces black smoke, it reduces poisonous lead and Sulphur Dioxide emissions to virtually zero. Some developed countries like the US have introduced it to reduce air pollution.

However, the EPD has reserved judgment because biodiesel could increase Nitrogen Oxides (a pollutant) in the exhaust compared with ordinary diesel. KMB's Mr. Shum said they will test the Nitrogen Oxide emissions in future biodiesel trials.

Mr. Shum said KMB had tested a pure vegetable oil biodiesel made in Germany, but because the price was several times more than ordinary diesel they had abandoned it. Instead KMB recently began cooperating with the University of Hong Kong and Better Environment Hong Kong. An HKU associate professer studied the use of waste cooking oil from grilling pork and made biodiesel for the KMB test.

Germany, USA and other countries are using biodiesel

Yesterday's tests used mixtures of biodiesel with ordinary diesel ranging from 10 to 15%, run separately on a KMB Cummins LT10 diesel test engine. The result showed the 15% mixture decreased black smoke by 7%, although the power decreased slightly and fuel consumption increased by 1.7%.

KMB expressed satisfaction with this result and will continue investigating the best mixture of biodiesel with ordinary diesel fuel. After more detailed investigation, the company will consider whether to use it in buses. It will also need to consider the biodiesel supply problem.

Test results:

% of biodiesel: 0%: 15%: difference

Engine power (ton/meter): 993: 998: -0.5%
Engine Power (horse power): 239: 238: -0.4%
fuel economy: 0.229: 0.233: +1.7%
Black smoke amount: 38.5: 35.8: -7%

Test result satisfactory
KMB: Biodiesel effective to protect environment

Sing Tao
星島日報
June 27, 1999
九巴：生化柴
測試成效令

Sing Tao
Sunday 27th June 1999

KMB (Kowloon Motor Bus) and Better Environment Hong Kong (BEHK) conducted a test of biodiesel to replace ordinary diesel fuel, and the result of the initial study was good. However, it still needs more detailed study before they try it on the road.

Leung Yiu-cheong, an associate professor at the University of Hong Kong Department of Mechanical Engineering, who conducted the test, explained that in this test they had used animal fat used for BBQ to make biodiesel, mixed it at a ratio of 10-15% with ordinary diesel fuel, and tested it in a bus engine. The results were that the more biodiesel was in the fuel the more the black smoke decreased, although engine power also decreased slightly. This will help to solve the air pollution problem.

KMB engineering manager Shum Yuet-hung said the test result was satisfactory. He emphasized the bus engines do not need to be modified to use biodiesel. But since the biodiesel study is still in the early stages and further improvements can be made, KMB does not plan to use it yet.

Mr. Leung added that this was the first test, and their aim is to find the optimum amount of biodiesel to mix with ordinary diesel. He said they will continue trying different proportions of biodiesel in the mix. He also said that using animal fat to make biodiesel decreases exhaust Nitrogen Dioxide and pollutant particles compared with biodiesel made from vegetable oil.

Today, overseas countries produce large amounts of ordinary diesel and biodiesel, and the prices are very similar. But if we produce a large amount of biodiesel in Hong Kong, Mr. Leung thinks the biggest problem will be collection and transport.

Another BEHK member conducting the tests, Choi Sau-yim, said in the second stage of the study, in addition to the bus tests, they plan to use 60 vehicles of different kinds, including taxis, minibuses and others, for six months of tests.

After coordinating the results, the BEHK plans to submit its report to the Legislative Council for consideration.

Test results:

% of biodiesel: 0%: 10%: 15%

Engine power (ton/meter): 993: 993: 998
Engine Power (horse power): 239: 235: 238
fuel economy: 0.229: 0.236: 0.233

Black smoke amount: 38.5: 36.7: 35.8

Twenty Minibuses will try Biodiesel in October

Hong Kong Economic Times
July 5, 1999
經濟日報
20輛小巴 10月試用生化柴油
商會與環保機構合作 原料來自食肆

Hong Kong Economic Times
Hong Kong News A17
Monday 5th July 1999

Industry and environment organization cooperate; fuel ingredients from our own food

Making biodiesel fuel from animal fats and plant oils to decrease air pollution -- is this be the way to go? Although the Environmental Protection Department (EPD) says "No", a minibus industry association plans to test biodiesel in 20 minibuses on the road in October, in cooperation with Better Environment Hong Kong.

KMB tested the same fuel last week

This biodiesel, which KMB (Kowloon Motor Bus) also tested in a bus engine last Saturday, is made from used BBQ oil from restaurants. By adding methanol in a chemical reaction, the cooking oil can be made into fuel to run diesel engines, without having to modify the engines.

Hong Kong-Kowloon-New Territories public minibus association chairman Mr. Leung Hung said they wanted to try biodiesel in 20 minibuses, both new and old, on short and long-range routes, to test the effect.

He said taxis using LPG (Liquid Petroleum Gas) faced a lack of filling stations, while there were very few mechanics qualified for LPG, and maintenance costs and fuel costs were a problem. He hoped that by studying the effect of biodiesel a better solution could be found to improve the environment.

EPD: it won't help to decrease air pollution

Recently, quite a few people are promoting biodiesel in Hong Kong. A commercial organization is trying to introduce biodiesel from Malaysia, and two foreign journalists in Lantau made their own biodiesel at home in their kichen from McDonald's used cooking oil, planning to drive their cars from Hong Kong to South Africa.

However, the Hong Kong government is not enthusiastic about biodiesel. An EPD

spokesman said: "Using biodiesel as a fuel for vehicles could increase Nitrogen Oxide (NOx) emissions in exhaust gas. NOx is already high in Hong Kong's Air Pollution Index, so using biodiesel will not improve Hong Kong's air pollution problem."

Using animal fats can reduce NOx emissions

However, a US Department of Energy website says NOx emissions with biodiesel are "similar or much less" compared to petro diesel, depending on the engine and tests used.

The chairman of Better Environment Hong Kong, Mr. Choi Sau-yim, said: "The key is in the materials used. If animal fats are used to make biodiesel, it can cut NOx in the exhaust to about 5 to 10% less than petro diesel, while plant oil biodiesel increases it by 15%. If you choose the material (the origin of the cooking oil) carefully, it's not difficult to solve the NOx problem."

He also believes Hong Kong is more suitable for biodiesel than other countries. Because Hong Kong cooking uses more animal fat, the NOx problem can be more easily solved, the temperature is high so there is no danger that the animal oil will solidify in the engine, and the city area is concentrated which makes it easier to collect the used cooking oil.

Plan to negotiate next March

Currently in Hong Kong a litre of diesel costs HK$5.90 per litre including tax, Choi said. In the US biodiesel made from soybean oil costs about HK$6.00, and biodiesel made from other vegetable oils cost is about HK$3.00. In Hong Kong, the tax situation for biodiesel is unclear, so it is difficult to calculate what the cost of biodiesel will be in Hong Kong.

BEHK, academics and transport organizations plan to cooperate in negotiating with the EPD next March, and will conduct detailed tests hoping to provide a foundation for policy discussions.

Don't allow biodiesel opportunity to slip away

South China Morning Post
COMMENT
LETTERS TO THE EDITOR
Don't allow biodiesel opportunity to slip away

SCMP Letters to the Editor
Tuesday, July 20, 1999

On April 2 Paul Kember suggested in the South China Morning Post that the Government introduce biodiesel instead of liquid petroleum gas to cut air pollution.

He said biodiesel was a non-toxic fuel made from vegetable oils, and could be used in diesel engines without conversion, with immediate emission reductions and no need for new filling stations, and it could be made from used cooking oil, a toxic waste.

"Information can be found on the Internet," he said. "Just Net search 'biodiesel'."

We'd done that some months before and found thousands of research reports, results of field tests totalling millions of miles, and even do-it-yourself kitchen recipes.

There's certainly no mystery about biodiesel -- except in Hong Kong, it seems, where some strange statements have been made recently.

We're interested in do-it-yourself biodiesel: we're organizing a long-range overland expedition with an environmental angle (Journey to Forever) and we want to use renewable fuels for our Land Rovers, one of which is a diesel.

So we brewed up some biodiesel in our kitchen from used cooking oil we got from McDonald's. On April 22 we put it in the Land Rover and it ran like a dream and smelled like a bunch of roses! Well, French fried roses anyway. Biodiesel exhaust doesn't stink.

On April 30 Ming Pao Daily published an article about this, but the Environmental Protection Department said it has rejected biodiesel because it increases Nitrous Oxide (NOx) emissions. Legislator Christine Loh said the EPD was being "short-sighted", and we quoted some scientific references to show it was wrong.

Two weeks later the EPD told Ming Pao that it still had doubts about NOx but now had an open mind about biodiesel and would investigate further, since we'd shown it could be made by recycling used cooking oil, giving it a dual purpose. Later Ms Loh confirmed to us that the EPD had changed its stance.

But three weeks ago the EPD told a Hong Kong Economic Times reporter it rejected biodiesel because it increases NOx emissions. What happened to its "open mind"?

Does biodiesel increase NOx emissions? Sometimes yes, sometimes no, but it doesn't matter. According to research (lots of it), there are reliable and proven ways of reducing biodiesel NOx emissions to below ordinary diesel fuel levels, by retarding the engine injection timing, and also by using additives and catalytic converters.

In one case using these techniques, certified emissions for diesel buses by the US Environmental Protection Agency showed NOx reductions of up to 28% less than conventional diesel fuel levels. NOx is not an issue with biodiesel.

Meanwhile work is going ahead here with biodiesel, but is apparently being skewed by the EPD's stance on NOx.

Recent reports have quoted local experts testing biodiesel made from waste animal fat as claiming that:
- Animal-fat biodiesel cuts NOx emissions to 5-10% less than ordinary diesel fuel, while vegetable-oil biodiesel increases NOx by 15%.
- Animal fat biodiesel has lower NOx and particulate matter (PM) emissions than biodiesel made from vegetable oil.

Some studies have shown lower NOx emissions with animal-fat biodiesel than with virgin vegetable oils, because fats have different combustion characteristics.

However, recycled oils and palm oils have similar profiles to fats -- there is little difference between NOx emissions from animal-fat biodiesel and biodiesel made from used vegetable cooking oils or from palm oil.

The 28% NOx reduction certified by the US EPA cited above was with vegetable-oil biodiesel, and was coupled with a 25% PM reduction.

Claiming that animal-fat biodiesel is safer could mean missing the opportunity to recycle all used cooking oils into biodiesel and would greatly reduce the amount of biodiesel that could be made in Hong Kong, and raise the cost.

KEITH ADDISON and
MIDORI HIRAGA
Handmade Projects
Lantau Island

So negative

South China Morning Post
COMMENT
So negative

SCMP Letters to the Editor
28 July 1999

Keith Addison is right to ask the Environmental Protection Department to explain its shilly shallying on biodiesel (letter South China Morning Post July 20).

All too often bright ideas are dismissed out of hand by Hong Kong's government bodies unless and until a multi-million dollar study is conducted.

The Government has rejected the A21 additive allowing water to be added to diesel and a massive reduction in nitrous oxide and particulates. It refuses to allow diesel-conversion kits, arguing they may not be carried out properly and thereby

prove a hazard.

It refuses to give the concessions that would encourage the use of electric vehicles. Various reasons are given, mostly relating to "lack of power", "limited range", etc.

This is despite China Light & Power's (CLP) 10-plus-year experiment proving its electric vehicles can tackle the Jat's Incline as well as their diesel equivalents; that milk has been delivered by electric vehicles to houses at the top of steep hills in the UK for the past 50 years; and the range available now is more than enough for a range of operations.

It even stifled the KMB/CLP electric airport coach concept. The Government has always sought the impossible 100 per cent solution to any problem, ignoring the fact that every option, no matter how limited its application, will make a meaningful contribution.

DAVID SLOUGH
Lamma

Interested in biodiesel as renewable energy

South China Morning Post
COMMENT
LETTERS TO THE EDITOR
Interested in biodiesel as renewable energy

SCMP Letters to the Editor
Wednesday, August 4, 1999

I refer to the letter by Keith Addison and Midori Hiraga (South China Morning Post, July 20) about biodiesel.

Liquefied petroleum gas (LPG) is a lot cleaner than biodiesel. An LPG taxi emits virtually no particulates and about 70 per cent less nitrogen oxides than a diesel taxi.

However, powering a diesel vehicle by biodiesel can have only about 15 per cent reduction in particulates but, as is widely recognized, up to about 14 per cent increase in nitrogen oxides emissions. We know of no countries relying on biodiesel to reduce the emissions from motor vehicles. The main drive for biodiesel in overseas countries is to exploit surplus agricultural products or treat it as a form of renewable energy.

Motor vehicles are a major source of ambient nitrogen oxides in Hong Kong. This year, we have so far encountered 28 incidents of the roadside Air Pollution Index reaching very high levels due to high concentrations of ambient nitrogen dioxide. More nitrogen oxides emissions from the vehicle fleet will cause more incidents of

the Air Pollution Index reaching very high levels. One can do little to reduce the nitrogen oxides emission from an in-use diesel vehicle.

All the measures mentioned by your correspondents have severe constraints or have yet to be developed. While retarding the timing of fuel injection can reduce the nitrogen oxides emissions, it will increase particulates emission and fuel consumption. Catalysts capable of reducing nitrogen oxides are still at the stage of prototype testing. Fuel additives for reducing nitrogen oxides emission are not yet developed.

There are also doubts on the compatibility of biodiesel with existing motor vehicles.

The American Automobile Manufacturers Association, European Automobile Manufacturers Association, Engine Manufacturers Association and Japan Automobile Manufacturers Association jointly issued a report on vehicle fuel last December. They raised, among other things, their concerns on the long-term compatibility of biodiesel with their engine components. They considered that the content of biodiesel in diesel should not be more than five per cent.

The Hong Kong Motor Traders Association objects to using pure biodiesel as a motor fuel and is concerned by its long-term compatibility with engine components even for a smaller mix proportion of biodiesel.

Biodiesel is certainly not a fuel that can help reduce our air pollution problems that are mainly caused by diesel vehicles. Although limiting its content in diesel can reduce the increase in nitrogen oxides emissions, the reduction in particulates emissions will also be diminished.

While we are seeking clean alternatives to diesel, we are also looking to ultra-low sulphur diesel as a less polluting diesel. It can reduce the emissions of both particulates and nitrogen oxides from a vehicle.

At the moment, the oil refineries capable of producing the fuel are mainly in Europe and its supply is somewhat limited. But, the fuel will become a norm for diesel in the European Union (EU) in 2005, tentatively. We would thus expect its availability to improve in the not too distant future. We are now consulting with the oil companies to bring in some ultra-low sulphur diesel for trial purposes and make it a standard requirement for diesel at the same pace as the EU.

In the interim, we are seeking to further reduce the sulphur content of diesel to 0.035 per cent to enable less polluting diesel vehicles to be introduced in 2001. The new generation of diesel vehicles coupled with the less sulphur-containing diesel will have their emission of particulates and nitrogen oxides reduced by about 33 per cent and 30 per cent respectively when compared with the current models.

Nevertheless, we are interested in biodiesel as a form of renewable energy and also

any means that may help reduce waste requiring disposal and will continue to examine the development of new technologies in such areas.

W.C. MOK
Principal Environmental Protection Officer
for Director of Environmental Protection

Biodiesel Home Page (National Biodiesel Board)
Re: Hong Kong EPD's view on biodiesel

Message:

Posted by Mike on August 09, 1999 at 18:09:03:
In Reply to: Hong Kong EPD's view on biodiesel posted by Keith Addison on August 04, 1999 at 17:11:14:

Sorry, I read this letter and can't help feeling that MOK is the public relations/damage control for the oil companies. Yes I agree that biodiesel has increased amounts of nitrous oxides but except for cold climate usages of the fuel that is the only real disadvantage of the fuel as I see it. I am not downplaying the problem of the NOx's, they are real and also I'm sure have remedies such as tuning out that additional 10-15% increase in horsepower to cut down NOx or possibly some other way. What I find interesting in MOK's pushing fossil-based fuels is he makes no mention at all of biodiesel's ability to reduce carbon dioxide gas build-up in the atmosphere. This is accomplished by the initial plant growth for the feed stock of the oil. The photosynthesis process pulls more CO2 out of the atmosphere and converts it to plant tissue than is admitted by later burning the same oil out through the vehicle's tailpipe. On the other hand in burning fossil diesel there is no additional mechanism in our earth's biosystem to pull out all the additional CO2 created in burning the fossil fuels. This carbon is literally pumped up out of the ground and displaced into the atmosphere. As far as the other emissions that come out of the tailpipe, there are lots of completed and on-going tests being done on this fuel, to learn more about their findings one only needs to WEB search under biodiesel to a couple schools and other institutions that have been working on these tests. For myself after using the fuel in a few different vehicles for the past 2 and half years I'm convinced it is far superior to fossil diesel and after showing anyone else the tailpipe smoke or (lack of visible black smoke) it becomes pretty easy to win them over too. I have not even gone into the beauty of this fuel for its biodegradable nature nor a couple of its other positive qualities that win hands down over fossil diesel. In closing it's important to mention, this is only ONE piece to the puzzle of us all getting onto the path of a sustainable future. The biggest one of these puzzle pieces is energy conservation, the great under-tapped resource. Mike Pelly

Government's LPG policy offers no solutions

South China Morning Post
COMMENT
LETTERS TO THE EDITOR
Government's LPG policy offers no solutions

SCMP Letters to the Editor
Thursday, August 19, 1999

I refer to the letter by W. C. Mok of the Environmental Protection Department (EPD), on biodiesel (South China Morning Post, August 4).

In Germany many vehicles are now certified for 100 per cent biodiesel use. Most European carmakers now provide warranties covering biodiesel. More than 900 filling stations in Germany sell biodiesel, and it is cheaper than fossil diesel fuel.

Hong Kong's air quality is bad and deteriorating, and the Government offers no real solutions. The EPD proposes converting diesel taxis to liquefied petroleum gas (LPG), but ignores measures such as stringent annual emissions tests and high penalties for smoking vehicles.

Countries such as Germany and Holland are moving away from LPG to cut pollution while we waste resources on converting a few vehicles and building a new fuel distribution network for LPG in the vain hope that this will solve the problem.

The latest Japanese emissions standards for new vehicles are the same for LPG and unleaded petrol, so why convert? Why not just use unleaded petrol?

The Kyoto Protocol on greenhouse gases requires renewable energy resources such as biofuels to be increasingly cheaper than non-renewable resources such as fossil fuels (LPG, petrol, diesel). Biodiesel emits only 10 per cent of the carbon emitted by fossil diesel.

Governments not conforming to the Kyoto Protocol will increasingly be excluded from the mainstream of economic development.

Countries such as Germany have taken the World Health Organization (WHO) objectives for air quality to heart and are moving towards meeting both health and economic objectives within the framework of the Kyoto Protocol.

Many biodiesel dynamometer test results contradict those Mr Mok quotes. For instance, Michael E. Starr (Journal of the Society of Automotive Engineers, US, 1997) clearly demonstrates reductions of five to 20 per cent in both particulates and nitrogen oxides at different injector timings for pure biodiesel and for biodiesel/fossil

diesel blends. Fossil diesel and biodiesel are different fuels and require different tests. Maybe this is where Mr Mok went wrong.

Mr Mok's view of particulates is simplistic. The WHO health objectives stipulate zero tolerance of particulates - humans should not breathe air containing particulates - but the Government has done nothing to reduce the health risk from vehicle particulates.

Ultra-fine particulates pose the greatest health hazard because with fossil fuels they contain heavy metals which are absorbed directly into our bloodstream; this remains outside the Government's view. Biodiesel made from pure biofuels contains no heavy metals.

Mr Mok says catalytic converters are only in the prototype stage. Not so, they are readily available. Special oxidation catalytic converters for use with pure biodiesel reduce particulates by up to 50 per cent, and decrease nitrogen oxides.

Reducing the sulphur content of diesel fuel in South China might be more effective than Mr Mok's proposal to use ultra-low-sulphur diesel in Hong Kong.

Chinese diesel has 10 times more sulphur than the fuel sold here. Almost as much half-price illegal diesel smuggled from the mainland is used in Hong Kong as legal diesel. Does the EPD calculate this when it proposes reducing emissions with ultra-low-sulphur diesel?

Ultra-low-sulphur diesel fuel can only be used on newer engines because of its low lubricity. Used as an additive, biodiesel (which contains no sulphur) increases lubricity and can extend the market for ultra-low-sulphur diesel.

However, carbon emissions significantly increase in refining ultra-low-sulphur diesel, flouting the Kyoto Protocol. I understand that diesel fuel sold in Hong Kong is refined in Singapore, which has no plans for refining ultra-low-sulphur diesel fuel, because of the small size of the Hong Kong market and low regional demand.

Does the Government have any program for its own vehicles for developing or implementing technology to improve air quality?

California's clean-air programs and legislation have created new technologies such as fuel cells, while Hong Kong cannot even raise the penalty for the few smoking vehicles ticketed.

Paul D. Tarrant
Yuen Long

Minibus takes landmark trip on sunflower power

South China Morning Post
September 28, 1999
Minibus takes landmark trip on sunflower power

South China Morning Post Front page
Tuesday September 28, 1999
By ANNE STEWART

A minibus using fuel made from sunflower oil drove from Central to Repulse Bay yesterday.

It took the company which wants to import and distribute the oil, widely used in Germany, 18 months to get permission for the 10-kilometre journey.

"We started explaining what we wanted to do to the Environmental Protection Department a year and a half ago," said Russell Sung Yan-tak, manager of Sunland. "They have given us feedback which is helping us develop ... After many letters we got permission for this small demonstration."

Driver Choi Hang-wan took a drink of the fuel and said: "It tastes fine. It's OK," although officials are unlikely to recommend the practise.

Principal Environmental Protection Officer Mok Wai-chuen said biodiesel was 15 per cent less polluting than diesel, but LPG, which the Government is trying to introduce, achieved a 70 per cent reduction.

Bio-diesel increased nitrogen dioxide emissions, Mr Mok said.

Mr Sung has the support of Citizens Party legislator Christine Loh Kung-wai. "There are so many possibilities and interesting commercial opportunities in this area, and it's encouraging that Hong Kong companies want to do something," she said.

"There should be an environment that will allow people to use different fuels with lower air pollutants."

Caption:
Taste test
Minibus driver Choi Hang-wan takes a drink of the biodiesel after the test drive from Central to Repulse Bay. "It tastes fine," he said.

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NOx and biodiesel

Nitrous Oxide emissions with biodiesel, taken from various scientific and industry studies.

Biodiesel smells yummy!

1. "Adjustment of injection timing and engine operating temperature will result in these levels [of nitrous oxides with biodiesel] being reduced below mineral diesel levels." -- Dr Kerr Walker, Scottish Agricultural College, 1994, in "Biodiesel from Rapeseed", Journal of the Royal Agricultural Society of England, Volume 155, p. 43-4.

2. "Nitrous Oxides (NOx) are reported by several researchers to be increased with Biodiesel. However, our own data shows a reduction in nitrous oxides, very consistently, throughout all these [dynamometer] tests. NOx started at 6.2 gm/mile for diesel and goes down to around 5.6 gm/mile with 100% ester (Biodiesel), with slightly more reduction with REE (rapeseed ethyl ester) than RME (rapeseed methyl ester)... Emissions results for 100 percent ester compared with diesel control fuel show a 53% reduction in HC (Hydrocarbons), a 50% reduction in CO (Carbon monoxide), 10% reduction in NOx and 13.6% increase in PM (particulate matter)." -- "Toxicology, Biodegradability and Environmental Benefits of Biodiesel", Charles L. Peterson and Daryl Reece, Professor and Engineering Technician, Department of Agricultural Engineering, University of Idaho, 1994

3. "Fueling with biodiesel/diesel fuel blends reduced particulate matter (PM), total hydrocarbons (THC), and carbon monoxide (CO), while increasing oxides of nitrogen (NOx). Retarded fuel injection timing reduced NOx emissions while maintaining the other emissions reductions." -- "6V-92TA DDC Engine Exhaust Emission Tests using Methyl Ester [Biodiesel]", L. G. Schumacher (Department of Agricultural Engineering at the University of Missouri), D. Fosseen, W. Goetz, S. C. Borgelt, W. G. Hires (1995) in Bioresource Technology, 1995

4. "As the concentration of biodiesel increased, the oxides of nitrogen [NOx] emissions increased. The B20A20 fuel blend effectively reduced the oxides of nitrogen emissions below that of baseline diesel fuel. Retarding the timing was an effective way of reducing NOx emissions when fueling with the biodiesel blends. Oxides of nitrogen emissions ... can be successfully reduced

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below that of baseline diesel fuel by either retarding injection timing or replacing 20 percent of the baseline diesel fuel of the B20 blend with heavy alkylate." -- "Engine Exhaust Emissions Evaluation of a Cummins L10E When Fueled with a Biodiesel Blend", William Marshall, Leon G. Schumacher, Steve Howell (1995), Society of Automotive Engineers, SAE Paper # 952363
[B20 = a blend of 20% biodiesel with 80% conventional low sulfur petroleum diesel fuel
B20A20 = a blend of 20% biodiesel and 20% heavy alkylate with 60% conventional low-sulfur petroleum diesel fuel]

5. "Nitrogen Oxides (NOx) emissions from biodiesel increase or decrease depending on the engine family and testing procedures. NOx emissions (a contributing factor in the localized formation of smog and ozone) from pure (100%) biodiesel increased in this test by 13 percent. However, biodiesel's lack of sulfur allows the use of NOx control technologies that cannot be used with conventional diesel. So, biodiesel NOx emissions can be effectively managed and efficiently eliminated as a concern of the fuel's use." -- US National Biodiesel Board, Biodiesel Report, April 1998, "Biodiesel First Alternative Fuel to Meet EPA Health Effects Requirement -- Positive environmental and health effects results for Biodiesel"
[Sulphur content of methyl ester biodiesel: less than 0.001 percentage weight.
Sulphur content of low-sulphur conventional diesel fuel: 0.05 percentage weight]

6. "There are reliable, proven methods for baselining or even reducing Nitrous Oxides (NOx) produced when using biodiesel. I have certified emissions for the urban bus retrofit program with EPA (US Environmental Protection Agency) using this technology. This package included use of an oxidation catalyst to maximize Particulate Matter (PM) reductions (taking advantage of the high soluble organic fraction of biodiesel) and a timing change to give up some PM reductions while reducing NOx to baseline or even past baseline -- the best case was a 28% NOx reduction with a 25% PM reduction." -- (From a personal communication, Ming Tseng, Aiko Associates LLC, USA, biodiesel suppliers)

See also:

Bibliography of Water-Fuel Emulsions Studies -- A list of studies that are being considered for inclusion in work being done by EPA to assess the effects of water-fuel emulsions on emissions of oxides of nitrogen (NOx), hydrocarbons (HC), and

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particulate matter (PM) (including 23 studies of diesel water-fuel emulsions). Acrobat file, 12kb.
http://www.epa.gov/otaq/models/analysis/emulsion/emulbibl.pdf

Emulsions of Hydrated Ethanol in Hydrocarbon Fuels, by Apace Research Ltd - Executive Summary of report for Australia's for the Energy Research and Development Corporation (ERDC) -- reports on hydrated ethanol/diesel fuel emulsion, or "diesohol", and hydrated ethanol/petrol emulsion.
http://www.eidn.com.au/energyerdcemulsions.htm

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The only real "cake" of soap we've ever seen -- solidified glycerine from the bottom of our first-ever biodiesel.

General

Glycerine (glycerin, glycerol) is the main by-product of making biodiesel. The name comes from the Greek word *glykys* meaning sweet. It is a colorless, odorless, viscous, nontoxic liquid with a very sweet taste and has literally thousands of uses. That is, pure glycerine has thousands of uses -- the biodiesel by-product is crude (and it's not colorless, and it's not only glycerine).

Lots of information on glycerine, from a Japanese manufacturer (in English) -- Sakamoto Yakuhin Kogyo Co., Ltd.:
http://www.sy-kogyo.co.jp/english/sei/1_gly.html

Glycerin -- King's American Dispensatory, by Harvey Wickes Felter, M.D., and John Uri Lloyd, Phr. M., Ph. D., 1898
http://www.ibiblio.org/herbmed/eclectic/kings/glycerinum.html

Burning glycerine

The glycerine by-product burns well, but unless it's properly combusted at high temperatures it will release acrolein, which is toxic. The **Mother Earth Waste Oil Heater** or other waste oil burners are suitable.

We thought of mixing it with sawdust to make briquettes, and in a message to the **Biofuel** mailing list Tony Clark suggested using milk cartons instead of making briquettes: "A 1-litre milk carton (1 quart US)

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of this mixture will give off more heat than twice or three times that weight in firewood."

We found a 1-litre milk carton will hold 450 gm of wood-shavings and 750 gm of by-product. Three milk cartons burn for about 45 minutes and will heat 80 litres of water from room temperature to 60 deg C (140 deg F). We start the fire with wood to get the burning chamber to a high temperature before adding the milk-carton "logs".

Three milk-carton glycerine-sawdust "logs" are enough to heat our bath.

Some biodiesel brewers are burning the by-product raw to provide heat for the biodiesel process. They use pot burners with a forced air supply piped in from an external fan. There are various designs being used, and a variety of ways of controlling the fuel supply and pre-heating the by-product so it flows evenly to the burner.

Filling a milk carton with wood shavings...

We've found the separated FFAs from the by-product (see next) also work well in such burners, and so does WVO.

... adding the by-product, then tamp it down hard with a piece of 2x2 -- the soiled newspaper makes a good fire-starter.

Separating the glycerine

What sinks to the bottom of the biodiesel processor during the settling stage is a mixture of glycerine, methanol, soaps and the lye catalyst. Most of the excess methanol and most of the catalyst remains in this layer. Once separated from the biodiesel, adding phosphoric acid to the glycerine layer precipitates the catalyst out and also converts the soaps back to free fatty acids (FFAs), which float on top. You're left with a light-colored precipitate on the bottom, glycerine/methanol/water in the middle, and FFA on top. The glycerine will be approx. 95% pure, a much more attractive product to sell to refiners. Here's how to do it: **Separating glycerine/FFAs**

A commonly asked question: How much glycerine do you get? A better question would be: How much of the "glycerine layer" is actually

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glycerine? The rule of thumb is 79 milliliters of glycerine per liter of oil used -- 7.9%. In fact there's usually more soap -- the "glycerine" layer is more of a "soap" layer than anything else. Unless you use Aleks Kac's **"Foolproof" acid-base two-stage process**, that is -- see this photograph and the caption for an idea of how much less soap you'll make.

Purifying glycerine

Biodiesel can be made with ethanol (which you can make yourself), instead of methanol (which is toxic, fossil-fuel derived, and you can't make it yourself). Here's a recipe: **Optimization of a Batch Type Ethyl Ester Process**. But the ethanol has to be anhydrous -- free of water -- which can't be achieved by distillation. One way to dry it is to use the by-product of making biodiesel -- glycerine. Here's how:

Absolute Alcohol Using Glycerine -- Mariller-Granger Processes, from E. Boullanger: Distillerie Agricole et Industrielle (Paris: Ballire, 1924). Mariller's absolute alcohol production process by dehydration using glycerine, various systems examined and explained. Translation from the French by F. Marc de Piolenc.

But -- the glycerine has to be 99%+ pure. Purifying it is no simple matter -- it's difficult to distill it because glycerine has a very high boiling point (290 deg C). Here's one way:

Solvent purification distillers by **Recycling Sciences, Inc**. Set the temperature and leave it alone. It'll purify the glycerine, at a price. They offer a special unit for biodiesel makers, price US$31,000 for a unit that will do 100 gallons an hour of any solvent recycling -- methanol/ethanol recovery from a biodiesel/glycerine solution before separation, pure glycerine from the crude process by-product, etc, in a very safe manner. Second-hand units can be found for as little as $5,000, but make sure it's the biodiesel model (much quicker). (Information provided by David Hollenback at the University of Idaho and Steve Woolcott, HarvestEnergy, Sydney, Australia)
http://www.rescience.com

Paintbrush cleaner

From **Tony Clark**, President of the Western Australian Renewable Fuels Association Inc.
http://www.shortcircuit.com.au/warfa/warfa.htm
Email "Anthony R Clark" <ar.clark@bigpond.com>

I have another use for the by-product from biodiesel production -- cleaning paint brushes which have been used with oil-based paints. I have found it to be superior to turps (turpentine), and have not had the brush harden from residual paint.

1. With the oily brush, dilute the paint in the brush (with biodiesel or turps) until it is runny when the brush is pushed onto a firm surface. I used about 50ml with a 2" brush.
2. Work the brush to ensure that the bristles are fully moisened.
3. Remove from dilution liquid.
4. Work brush in a small container with about 20 ml of glycerin, more for bigger brush/container (you will see the paint coming out).
5. Rinse brush under water until all milkiness is removed.
6. If brush still shows signs of paint, repeat glycerin stage with fresh glycerin.
7. Check that brush doesn't smell of paint and store brush as usual.

I disposed of the paint / biodiesel / glycerin / wash water in the compost.

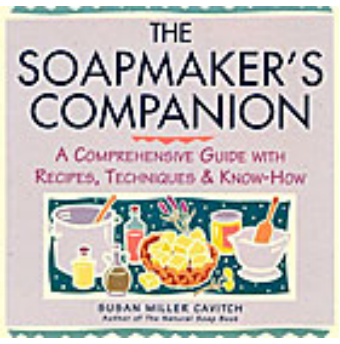
Soap

The crude glycerine by-product from homemade biodiesel makes a powerful degreaser. First remove any methanol residue -- either boil it off (NOT over an open flame, do it in the open, don't inhale any fumes), or (better) heat it to 65-70 deg C (150-160 deg F) in a closed vessel and recover the methanol for reuse via a simple condensor.

If you separate the glycerine by-product from the impurities (see **Separating glycerine/FFAs**), you'll be left with about 95% pure glycerine. You can add it to plain liquid soap to make a high-glycerine shower-soap or shampoo. It doesn't need much -- try 10 to 20cc per 500cc of liquid soap, and add some essential oils for fragrance.

Glycerine is a natural by-product of the soapmaking process, and hence the boom in do-it-yourself craft soapmaking -- and the high prices of handmade soaps. Glycerine moisturizes the skin, but commercial soap manufacturers remove the glycerine for use in lotions and creams, which are more profitable. Handcrafted soap retains the glycerine and is soft and kind to the skin.

Excellent soap book



The Soapmaker's Companion: A Comprehensive Guide With Recipes, Techniques & Know-How, by Susan Miller Cavitch, Storey Books, 1997, ISBN: 0882669656
Recommended by Todd Swearingen, and, after we bought it, endorsed by us -- great on soap and of much interest to all biodiesellers. One reviewer said: "This was the most complete book on soapmaking I've ever read. The first to actually explain the

chemistry & give formulas to figure the ratios of lye to fat." From Storey Books:
http://www.storeybooks.com/sell_sheet_frames/bodycare/965-6prim.html

Web resources

So, you want to make soap? -- by Elaine White, author of "Soap Recipes: Seventy tried-and-true ways to make modern soap with herbs, beeswax and vegetable oils".
http://www.fragrant.demon.co.uk/makesoap.html

How to Make Soap From Scratch -- "Making soap base is a cumbersome task, however, it is so rewarding to change the nature of natural things. What once was fat, water and lye turns into a beautiful, rich and creamy soap!" -- Soap Crafters Company. Full details, well illustrated.
http://www.soapcrafters.com/makebase.htm

Pathetic Plantation's soap making tutorial -- Detailed soap making instructions, with photographs.
http://www.hometown.aol.com/thesoapmaker/soapmakingtutorial.htm

Online **Lye Calculator** at Majestic Mountain Sage helps soap makers calculate their soap formulations. Extensive soapmaking resources at this site.
http://www.thesage.com/calcs/lyecalc.html

SAP values -- To calculate the amount of lye needed to saponify the oils you plan to use look up the SAP value for each oil or fat under the type of lye you plan to use. Multiply the SAP value times the amount of oil or fat you plan to use. Add the amounts for each oil together to give you the correct amount of lye needed.
http://www.luxurylane.com/thelibrary/reference/sap.htm

The old way

Colonial soap making, history and techniques -- 5,250-word online booklet by Marietta Ellis of the Soap Factory, who has researched soap making techniques and the history of soap making for over 30 years. She also works with VITA (Volunteers In Technical Assistance), providing people in developing countries with soap making information. Detailed instructions, some illustrations, bibliography.
http://www.alcasoft.com/soapfact/history.html

LYE LEACHING APPARATUS

Soap Making - Traditional Methods -- Prepared from information in

many soap making books which describe old pioneering methods used up to the end of last century in America, Australia, Canada, and New Zealand, using substances which are easily found or made in most parts of the world, such as wood ash and rainwater. Many of these techniques are now being used in some African countries. 6,700-word article, with illustrations.
http://ourworld.compuserve.com/homepages/paul_norman_3/SOAPMAKE.HTM

Soap -- King's American Dispensatory, by Harvey Wickes Felter, M.D., and John Uri Lloyd, Phr. M., Ph. D., 1898
http://www.ibiblio.org/herbmed/eclectic/kings/sapo.html

Soap forums

Toiletries mailing list -- Large email discussion group for soapmakers, good reference library, ongoing co-ops for essential oils, bulk items, etc.
http://www.yahoogroups.com/community/1Toiletries

Toiletries Listservice web page -- Extensive soapmaking resources online, homepage of the Toiletries mailing list.
http://www.luxurylane.com/thelibrary/index.htm

Soap & Candle Making -- Web forum for those making soap and candles to share ideas and techniques. Post, browse or search messages.
http://forums.thathomesite.com/forums/soap/

See: **Natural vegetable soap**

Glop soap

If you use too much lye when trying to make biodiesel it won't separate into biodiesel and glycerine but turn instead into a sort of gloppy jelly, maybe with some soap solidified at the bottom. You can turn it into soap.

Pour off the jelly and heat it to 65-70 deg C (150-160 deg F) for 10-15 minutes to boil off any methanol residue (poisonous vapours, this needs good ventilation), or, better, use a closed container and recover the methanol via a simple condensor.

To turn the jelly into high-glycerine soap you need 135 grams of lye (caustic soda or sodium hydroxide, NaOH) per litre, minus the amount of lye you used in the first place. (Lye is dangerous: observe all safety precautions, wear protective clothing and eye protection, don't breathe any fumes. Lye reacts with aluminium, tin and zinc. Use glass, enamel or stainless steel containers.)

Soapmaking purists will object that the amount of lye needed depends on the saponification value of the type of oil or fat being used, but this is

probably used oil anyway, and 135 grams per litre is about average and should work. If not, see the soap links above for more information.

You also need a third as much water as jelly. The water should be lukewarm. Slowly add the lye to the water, stirring until it dissolves (avoid fumes, take safety precations). This heats the water: let it cool to lukewarm again. Heat the glop to about 45 deg C (no more) in a pot, and carefully add the water and lye, stirring constantly for 15-20 minutes, maintaining the heat, until the mixture starts to thicken.

When you can trace a line on the surface with a spoon and it stays there for a few seconds, add an essential oil of your choice to remove the fatty smell, and it's done.

Pour it into a bucket, cover it with a towel, and leave it for 24 hours. Then you can tip it out and cut it into bars. Let the bars cure for up to a month. (Freshly-made soap can burn the skin.)

In a nutshell:

"Don't do this with an open flame gas stove!

"Pick a soap recipe, pour glop into pot, subtract caustic already in glop from weight required by recipe, mix this amount of caustic with the specified amount of water, pour into pan, turn on medium heat, let residual methanol evaporate, don't breathe, stir to trace, pour into mold or other, wait two weeks, bathe either self or dog." -- Todd Swearingen, **Biofuels mailing list**

High-explosives

The most earth-shattering use of glycerine remains that discovered by Italian chemist Ascanio Sobrero 150 years ago when he subjected it to nitration to make the world's first real high-explosive, nitroglycerin, one of the most dangerous substances ever concocted.

Sobrero's face was badly scarred in an explosion during an early experiment. He said nitroglycerin was so dangerous it was useless, and it had killed so many people he was ashamed to be its discoverer.

But Swedish chemist Alfred Nobel set about mass-producing the stuff, in spite of several explosions -- one of which killed his brother. Nobel discovered that nitroglycerin could be mixed with silica (diatomaceous earth) to form a stable high-explosive which he called dynamite. It made him one of the richest men of the age.

Nitroglycerin is extremely powerful. A mere 10 ml will expand 10,000 times into 100 litres of gas at an explosive velocity of 7,700 metres per second (17,224 miles per hour) -- more powerful than TNT.

Alfred Nobel

It's easy to find recipes for nitroglycerin. You mix deadly compounds like sulphuric acid and nitric acid with the glycerine and unless you can control the following runaway reaction it explodes in your face. Most formulas carry warnings like these:

"**Caution:** Nitroglycerin is extremely sensitive to decomposition, heating, dropping, or jarring, and may explode even if left undisturbed and cool."

"**Caution:** Nitroglycerin has the capacity to sense when a stupid or clumsy person is around and, if given a chance, it will try to kill him."

"**Caution:** This formula assumes that the maker has no qualms about killing his/her self in the process."

These cautions are VERY well-founded!

Every now and then newspapers rediscover these "resources" on the World Wide Web and set up a hue-and-cry for Internet censorship, claiming it promotes terrorism, but any terrorist worth his Semtex knows better than these amateurish offerings.

Anyway these things have been around much longer than the Internet. We found a nitroglycerin recipe in a general how-to book published more than a century ago, along with a dozen other explosives, including dynamite. Did Civilization-As-We-Know-It survive? It's hard to tell!

Heart disease drug

"In one of the more curious coincidences of science, the first modern high explosive -- nitroglycerin -- also became one of the very first man-made drugs. To this day, it remains the most commonplace treatment for chronic angina, the chest pain of heart disease," writes cardiologist Esmond A. Barker, MD, in "Nitroglycerin is most frequent medication for chronic heart pain".
http://www.cardio.com/articles/nitrogly.htm

Nitroglycerin is a vasodilator -- it relaxes the blood vessels, reducing the pressure on the heart. There can be side-effects -- some patients get killer headaches, others low blood-pressure and dizziness -- and it can clash seriously with other drugs (see next). It comes in the form of tablets for under the tongue, ointment and skin patches -- and it cannot be turned into an explosive.

The dosages are low: the tablets contain a maximum of 0.6 mg nitroglycerin, the ointment is 2% nitroglycerin.

This may be because nitroglycerin isn't only a deadly explosive, it's also a

deadly poison: the lethal dose is only 2 grams, but toxicity begins with a much smaller amount.

Love potion

Nitroglycerin's action as an effective vasodilator led in 1998 to the release of **RESTORE**, the "first ever fully tested, effective topical cream for the safe treatment of male erectile dysfunction (impotence)". http://pharmacology.about.com/library/98news/bln0309a.htm

"Restore" contains 1% nitroglycerin and is "effective within minutes of application of achieving an erection of up to 45 minutes duration. No significant side effects or instances of priapism were reported."

Want to double the effect? Forget it: do NOT take **Viagra** (sildenafil) if you are taking any form of nitroglycerin, whether for heart pains or for heart pangs. The combination could kill you. http://www.cnn.com/HEALTH/9805/21/viagra.warning/

Safe sweetener

Glycerine is an alcohol (glycerol) and is used as a preservative in the food industry, as well as a sweetener: it is very sweet, yet it contains no sugar. This makes it an ideal sweetener for patients who cannot take sugar, such as the increasing number of Candida sufferers. Vegetable glycerine is said to be the "only acceptable sweetener" for Candida patients. Here are a couple of healthy recipes.

Sweet potato casserole

1/4 cup water
2 tablespoons 100% pure vegetable glycerin
2 teaspoon (alcohol free) orange flavouring
Ground cinnamon to taste
1/2 cup chopped or ground fresh walnuts
1/2 pound sweet potatoes, scrubbed, peeled and quartered

Preheat oven to 175C. Place sweet potatoes in a greased 8-inch casserole. Put all other ingredients into a small bowl: mix. Pour mixture over sweet potatoes and bake 35 minutes, or until fork-tender.

Vanilla Pecan Icecream

3 eggs
2 tablespoons softened butter (optional)
1/2 cup food-grade glycerine
2 cups (unsweetened) soy or almond milk
2 teaspoons vanilla
1/2 teaspoons sea salt (optional)
2 cups cream, or 2 extra cups of soy or almond milk to lower the

fat content
1/2 cup pecans (roast lightly in oven and cool before using)

Beat eggs and milk together in large saucepan on low heat. Stir constantly until thickened -- mixture should smoothly coat a spoon. Takes 5-10 minutes. Cool. Add glycerin, cream (or soy or almond milk), vanilla, salt, and pecans. Refrigerate overnight or longer. Process in icecream maker (or freeze). Add carob flour to make a chocolate version.

Health supplement

Health supplement for sportsmen -- Glycerine increases blood volume, enhances temperature regulation and improves exercise performance in the heat, or so it is claimed. It helps "hyperhydrate" the body by increasing blood volume levels and helping to delay dehydration. Following glycerol consumption, heart rate and body core temperature are lower during exercise in the heat, suggesting an ergogenic (performance enhancing) effect. In long duration activities, a larger supply of stored water may lead to a delay in dehydration and exhaustion. However, read the safety provisos.
http://www.supplementwatch.com/supatoz/supplement.asp?supplementId=152

Preserving plants

Mulberry leaves -- preserved (dark) and fresh-picked

This won't work with flowers. For foliage, cut sprigs or leaves, wash off any dust and dirt. Cut away the lower inch of the stem, and stand the specimen in a solution of two parts of water to one part of glycerine. Big, heavy leaves might do better in a 50-50 solution.

The leaves might change color with absorbtion. Ready when the entire leaf has changed color, having absorbed as much liquid as possible. The process takes a week or two. If the leaves start to droop, they've been in the solution too long.

Six hours later the fresh leaves have wilted

Take them out, wipe them off, tie a string round the stem and hang them upside down.

Another way is to completely submerge the leaves in the solution (you'll have to weigh them down). This method works better with some leaves.

When ready, wipe any moisture off the leaves. Wipe off any moisture or "leakage" for the first few weeks. They're now permanently preserved.

Photocopying -- from long before the age of photocopiers

Copying Pad for Taking Transfers of Writing.—White gelatine 4 ounces, water 8 ounces, glycerine 8 ounces, gum dextrine 2 ounces. Always use these same proportions for any amount. Melt the gelatine in the water at a gentle heat, add to it the glycerine, in which the gum dextrine has been thoroughly incorporated. Now stir all together, until thoroughly mixed, and then pour into pans of the desired size, to the depth of 1/2 inch.

RECIPE FOR INK TO BE USED.—Violet analine 40 grains, gum arabic 12 grains, alcohol 1/4 ounce, water 1/2 ounce; dissolve the gum in the water and alcohol, then add the analine. Shake in a bottle from time to time, until the analine is dissolved.

TO WORK THE COPYING PAD.—Write with the ink on any good paper, press the written surface on the pad, and allow it to remain two minutes; then take off and the writing will remain, from which impressions may be taken by laying on plain paper and smoothing with the hand. As soon as the last impression is taken, be sure and wash off with a wet sponge.
-- From "Lee's Priceless Recipes: 3000 secrets for the home, farm, laboratory, workshop and every department of human endeavor", Laird & Lee, Chicago, 1895 (facsim. Algrove, Ottawa, 1998).

Other uses

Glycerine is also a source of lecithin (used in foods as a fat emulsifier, and a vital component of all cell membrances in the body) and of tocopherols (vitamin E). It is used in skin moisturizers, lotions, deodorants, makeup, toothpaste, sweets and cakes, pharmaceuticals and patent medicines, in paper manufacturing, printing ink, in textiles, plastics, and electronic components.

Disposal

Failing all else, you can compost excess glycerine -- it is nontoxic and biodegrades quickly. It will need to be mixed thoroughly with other materials so that the air and bacteria can get at it, rather than a sticky mass. Composting should be "hot" compost -- aerobic, thermophilic compost that reaches high temperatures. See Journey to Forever's **Composting** pages.

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Natural vegetable soap

Many plants contain high levels of saponin, which is very soapy stuff. In the Hong Kong region, Chinese peasants traditionally used the small yellow fruit of the soap berry tree (*Sapindus mukorossi*) to make soap. Very easy to make: simply grinding up the rind and soaking it in water produces a soft liquid soap used for washing and as a shampoo -- popular with village women because it "beautifies the skin and removes freckles".

We tried it, some villagers showed us how to make it -- the soap worked really well, but we're not sure if it beautified us at all.

It's quite poisonous though -- drinking saponin will turn your blood into detergent. It's also a powerful fish poison. And, according to Dr James Duke's Phytochemical and Ethnobotanical Databases, it's also used in various parts of the world as a pediculicide, to treat boils, for chlorosis, as an emetic, for epilepsy, as an expectorant, to treat gum disease and bad breath, as a skin treatment, and to exorcise demons.
Phytochemical and Ethnobotanical Databases
http://www.ars-grin.gov/duke/

Both the fruit and roots are used in Chinese traditional medicine -- the fruit is steamed and dried repeatedly to remove the poison. It's used to treat colds, fever, acute bronchitis, cough, diphtheria, sore throat and indigestion.

Dr Duke lists the seeds of the horse-chestnut (*Aesculus hippocastanum L.*) as having the highest levels of saponin: 260,000 ppm. They don't grow here, so we haven't tried making soap out of horse-chestnuts.

Horse-chestnuts (Cornell)

It's also a fish-poison. Dr Duke lists the following uses of the horse-chestnut: as an alterative, analgesic, anodyne, astringent, for backache, for cancer, to treat fever, as a hemostatic, to treat malaria, as a narcotic, for neuralgia, pertussis, piles, rheumatism, rectitis, sclerosis (breast), sores, as a vasoconstrictor, as a tonic, and as a poison.

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In an interesting article called "Promising Phytomedicinals" he lists the horse-chestnut as a source of Aescin (anti-inflammatory). http://www.hort.purdue.edu/newcrop/proceedings1990/V1-491.html

The Canadian Poisonous Plants Information System says horse-chestnuts "have poisoned cattle, horses, and pigs, causing sickness and death. Human poisoning has also occurred". http://res.agr.ca/cgi-bin/brd/poisonpl/ddplant5?plant=Aesculus+hippocastanum&info=all&name=sci

Here's some 100-year-old prescription information for this soapy poisonous tonic medicine, from "Potter's Cyclopaedia of Botanical Drugs and Preparations", by R.C. Wren, F.L.S., Potter & Clarke, London, 2nd Edition.

> HORSE CHESTNUT. Aesculus Hippocastanum.
>
> N.O. Sapindaceae.
> Syn.—Hippocastanum vulgare, Gaertn.
>
> Parts used—Bark, fruit.
>
> Action—Tonic, narcotic, febrifuge. The bark is used in intermittent fevers infused with boiling water—1 ounce to a pint—and given in tablespoonful doses three to four times daily; this has also been used as an external application to ulcers. The fruits have been employed with success in treatment of rheumatic and neuralgic disorders; also for rectal complaints, backache, piles, &c.
>
> Preparations—Fluid extract, fruit: Dose, 5-20 drops. Fluid extract, bark: Dose, 1/2-2 drachms.
>
> Distinctive character—The bark occurs in flattened pieces 4-5 inches long, and about 1-1.5 inch broad, alla about 1-1.25 inch thick, greyish brown externally, with corky warts tangentially elongated on the inner surface, pinkish brown, and finely striated longitudinally. Fracture finely fibrous and laminate towards the inner surface. Taste, bitter and astringent. Odour, none. The fruit is a capsule, splitting into three valves, with short spines scattered on the surface, each containing a large brown polished seed, about 1 inch broad and inch thick, with a large dull, rough, and pale brown scar where it has been attached to the capsule. Seed white, giving a blue fluorescent infusion.

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What is Biodiesel?

Biodiesel is much cleaner than fossil-fuel diesel. It can be used in any diesel engine with no need for modifications -- in fact diesel engines run better and last longer with biodiesel. And it can easily be made from a common waste product -- used cooking oil.

The **US Department of Energy** -- "Biodiesel: the Clean, Green Fuel for Diesel Engines" (Acrobat file, 108kb):
http://www.ott.doe.gov/biofuels/pdfs/biodiesel_clean-green.pdf

SoyGold (AG Environmental Products L.L.C.)
http://www.soygold.com/biodiesel.htm

The **National Biodiesel Board's** Biodiesel Fuel Fact Sheets (Acrobat files)
http://www.biodiesel.org/resources/fuelfactsheets/

The **Biodiesel Association of Australia** FAQ -- see "Biodiesel Fact Sheets" and "Public FAQ"
http://www.biodiesel.org.au/

Home-made biodiesel

One of the most attractive aspects of biodiesel is that you don't have to be a government or an oil corporation to make it. Just about anyone can rig up a biodiesel fuel plant in the kitchen, or virtually anywhere, mostly using stuff you can find lying around, including the basic raw material -- waste cooking oil. The best part of it is that what you make is better than the fossil fuels the big guys make: it's cleaner, more eco-friendly, it's cheap, and it's better for diesel engines -- they run smoother and last longer on biodiesel.

Make your own biodiesel -- all you need to know.

Mike Pelly's biodiesel recipe -- this is the best how-to on the Web.

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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Aleks Kac's two-stage process -- high quality fuel and no titration.

FOOLPROOF biodiesel method -- fast becoming the method of choice for advanced biofuellers (including us!).

Steve Spence's **Renewable Energy Resources** has biodiesel information, links, related resources -- lots of information and resources on this site.
http://ww2.green-trust.org:8383/biodiesel.htm

Making biodiesel in the kitchen -- the man who started the do-it-yourself biodiesel movement, **Dr. Thomas B. Reed**, relates how he got the idea of making biodiesel from waste cooking oil ("McDiesel") in 1989, and tells you how to do it.
http://www.woodgas.com/Unlinked/biodiesel.htm
Also see Tom's Biomass Energy Foundation site:
http://www.woodgas.com/

Spanish-language site for DIY biodieselers, by Pedro Macanas of Murcia, Spain -- Pedro's got all the good stuff here: En esta página le enseñamos a fabricar caseramente su propio biodiesel y a utilizarlo en su actual vehículo de gasoil (es decir, no es neceario adquirir un nuevo coche, ni el realizar modificaciones en el mismo, para poder utilizarlo en cualquier vehículo de gasoil petrolífero). Los biocombustibles (o biofueles), como el biodiesel, son energía renovable, aunque son un paso transitorio e intermedio hacia una clase mejor mejor tipo de energía : las energías renovables no contaminantes.

Fat of The Land -- In 1994 four women from the California Bay Area travelled 3,000 miles around the US on biodiesel in their **Fat Mobile** diesel van on an educational tour. They made their biodiesel as they went along, usually in the parking lots of fast-food restaurants, and filmed a groundbreaking video documentary while they were at it. This is the recipe they used to make biodiesel:
http://www.dancingrabbit.org/biodiesel/flrecipe.html
Fat of the Land Video Documentary:
http://www.videoproject.org/FAT_OF_THE_LAND.html

Biofuels forums

The **Biofuel mailing list** run by Journey to Forever is the biggest and fastest-growing alternative fuels mailing list. An information-sharing resource for the rapidly growing number of people all over the world who are making their own fuel or would like to. Biodiesel and ethanol, also covers other alternative fuels and energy issues in general. List URL:
http://groups.yahoo.com/group/biofuel

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Search the **Biofuels archives** -- 30,000 entries from discussions by biofuellers all over the world, a treasure trove of information on all aspects of biofuels:
http://infoarchive.net/sgroup/biofuel/

The Biofuel list really helps biofuellers. A typical example: list member **Jack Kenworthy** of the Cape Eleuthera Island School in the Bahamas joined the list in November 2002 as a novice. List members helped him learn how to make biodiesel from scratch, helped him solve problems he encountered, then helped him design and build a processor. Nine months after joining he wrote to the list: "Hey All -- just thought I would let you know that I just received my results from the ASTM tests [the US ASTM D-6751 biodiesel standard] and we passed all categories. Just another good example of a homebrewer in a remote setting (Bahamas) making spec-grade biofuel! Thanks! -- Jack"

The **Biogasoil** Spanish biodiesel mailing list, run by Pedro Macanas -- Unase a la lista de correo sobre biogasoil:
http://es.egroups.com/group/biogasoil

The **Bioenergy Mailing List** at CREST (Center for Renewable Energy and Sustainable Technology), for the discussion of biomass as a sustainable energy resource. Searchable hypertext archives.
http://www.crest.org/discussiongroups/index.html

DieselNet General Forum:
http://www.dieselnet.com/ubb-cgi/Ultimate.cgi
"Express your opinions and ask questions on diesel engine emission issues. Discuss current news" -- active Web forum, news and other resources at DieselNet's homepage:
http://www.dieselnet.com/

Straight vegetable oil

See **Straight vegetable oil as diesel fuel**

Ethyl-esters biodiesel

Making ethyl-esters biodiesel using ethanol is a tricky process, not as simple as making methyl esters with methanol. But it can be done -- see **Ethyl esters -- making ethanol biodiesel**

Biodiesel information sources

The US **National Biodiesel Board** is a "not-for-profit corporation dedicated to the commercialization and industrialization of biodiesel". It runs the Biodiesel homepage,
http://www.biodiesel.org/
with lots of useful resources including one of the best technical databases on biodiesel research (searchable)...
http://www.biodiesel.org/resources/reportsdatabase/

The searchable message archives of Journey to Forever's **Biofuel mailing list** is an invaluable resource for biofuels information -- a repository of the experience and knowledge of the worldwide membership of this big, active list.
http://archive.nnytech.net/

The **University of Idaho's**
http://www.uidaho.edu/bae/biodiesel/
biodiesel pages -- "Pioneers in Biodiesel Research", University of Idaho researchers have been studying vegetable oil as an alternative fuel since 1979, including long-distance (200,000 miles) on-the-road tests. Slide show, current projects and findings, publications list: see "On-Road Testing of Biodiesel".
http://www.uidaho.edu/bae/biodiesel/research/past_research.html

The **Biodiesel Development Corporation** has lots of information on biodiesel -- what-is, why's and wherefore's on biodiesel and using it.
http://pipeline.to/biodiesel/

Research on biodiesel since 1992 by a leading researcher, **Leon G. Schumacher** of the Department of Agricultural Engineering at the University of Missouri.
http://web.missouri.edu/~pavt0689/biofuel.html
Some reports are downloadable.

"Technical Handbook for Marine Biodiesel In Recreational Boats" by Randall von Wedel, Ph.D., CytoCulture International, Inc., Second Edition, April 22, 1999 (prepared for the National Renewable Energy Laboratory, U.S. Department of Energy) -- of general interest, not just for boaters, 12,000-word online report.
http://www.cytoculture.com/Biodiesel%20Handbook.htm

"Chemical and Bioassay Analyses of Diesel and Biodiesel Particulate Matter: Pilot Study -- Final Report" by Norman Y. Kado, Robert A. Okamoto and Paul A. Kuzmicky, Department of Environmental Toxicology, University of California, Davis, California, November 1996. This is the UC Davis study that found that the use of pure biodiesel instead of petroleum-based diesel fuel could offer a 93.6% reduction in cancer risks from exhaust emissions exposure.

Full report -- Acrobat file, 3.1Mb.
Summary: the Summary, Results and Discussion sections of the report, in html format.

Terry de Winne's **Biofuels for Sustainable Transport** site focuses on the lack of UK Government Policy -- "So why does the British government tax biodiesel at the same rate (48.82p per litre) as fossil diesel?" To be kind, because they're muddled -- and how it was changed, thanks to a small contingent of campaigners. Terry -- alias Terry UK -- or Terry de Winne MF, to give him his full title, was awarded a Millennium Fellowship for his research into electric vehicles and biodiesel.
http://www.biofuels.fsnet.co.uk/
Sustainable Transport Fuels -- good roundup of the various contenders, with the focus on biodiesel and lots of well-annotated resources:
http://www.biofuels.fsnet.co.uk/sustain.htm
For the full story on biodiesel and UK taxation:
http://www.dewinne.freeserve.co.uk/bio.htm
For the British DTI's muddled attitude to energy:
http://www.biofuels.fsnet.co.uk/dtienergy.htm
"Green Fuel Challenge" -- the case for biofuels:
http://www.biofuels.fsnet.co.uk/challenge.htm
How the 2001 UK biodiesel Tax Break came about and Beyond: "Thus, biodiesel in the UK has got off to a begrudging start."
http://www.biofuels.fsnet.co.uk/capitulation.htm

The modelling of the biodiesel reaction -- As part of their work to design continuous reactor for the production of palm-oil methyl ester, Michael Allen and Gumpon Prateepchaikul at the Energy Group in the Department of Mechanical Engineering at Prince of Songkla University in Thailand produced a spreadsheet modelling the complex series of reversible reactions which take place during the biodiesel production process. You can use the spreadsheet to change one parameter in the process and see how it affects the others.

The **British Association of Bio Fuels and Oils (BABFO)** is dedicated to the promotion of transport fuels and oils from renewable sources. Biodiesel and ethanol are the two key fuels. Resources and links, information on emissions, and more:
http://www.biodiesel.co.uk/

The **EEC** strongly supports biofuels -- do a search on biodiesel here:
http://europa.eu.int/geninfo/query_en.htm

Biofuels -- European Commission Subprogramme on Energy (ENERGIE)
http://europa.eu.int/en/comm/dg17/atlas/html/biofuel.html

The **Austrian Biofuels Institute** -- an international centre of competence for liquid biofuels
http://www.biodiesel.at/index2.html

"**Biodiesel in Europe 2000** -- Biodiesel Processing Technologies and Future Market Development", J. Connemann, J. Fischer, paper presented at the symposion "Biodiesel -- Fuel from Vegetable Oils for Compression-Ignition Engines" at Ostfildern/Stuttgart, Germany, May 17, 1999 (4,000 words):
http://www.biodiesel.de/biodiesel2000.htm

The **Biodiesel Association of Australia** has been established "to promote and build a viable and ecologically sustainable biodiesel industry in Australia". Will offer supplies of biodiesel for registered members. FAQ, what-is, news & press, standards, documents, getting it, making it, events, and more.
http://www.biodiesel.org.au/

Australian Biofuels Association -- Industry group, useful online document library on biodiesel, ethanol and more, Australian and US research. Home page:
http://www.australianbiofuelsassociation.org.au/index.htm
Library:
http://www.australianbiofuelsassociation.org.au/WantToKnow/Pubs+Reports.htm

Determining the Influence of Contaminants on Biodiesel Properties, Jon H. Van Gerpen et al., Iowa State University, July 31, 1996 -- 12,000-word report on contaminants and their effects -- good reasons to wash your biodiesel. Acrobat file, 2.1Mb:
http://www.biodiesel.org/resources/reportsdatabase/reports/gen/19960731_gen014.pdf

Dealing with high levels of Free Fatty Acids (FFA): first stage alkaline reaction, second stage acid-based reaction -- "**Cost Reduction in Bio-Diesel Production**", B. Rice, A. Fröhlich and R. Leonard, Crops Research Centre, Oak Park, Carlow, Ireland.
http://www.teagasc.ie/research/reports/crops/4321/eopr-4321.htm

Open Directory Science: Technology: Energy: Renewable: Biomass and Biofuels -- listings of biofuels information sites, biodiesel, ethanol, and more.
http://dmoz.org/Science/Technology/Energy/Renewable/Biomass_and_Biofuels/

Methylation of fatty acids, William W. Christie, Scottish Crop Research Institute: Three interesting papers online:
Preparation of methyl esters -- Part 1. Lipid Technology, 2, 48-49 (1990).
Preparation of methyl esters -- Part 2. Lipid Technology, 2, 79-80 (1990).
Why I dislike boron trifluoride-methanol. Lipid Technology, 6, 66-68 (1994).
http://www.lipid.co.uk/infores/topics/methests/

DieselNet's **Diesel Emissions Online** says the "diesel engine is the most

efficient power plant among all known types of internal combustion engines", but "further progress in diesel emission control is needed". It hopes to "contribute to the development of the clean diesel engine of the future". News, resources, research reports, discussion forum.
http://www.dieselnet.com/

Griffin Industries of Kentucky, USA, processes used vegetable oils and fats to produce 2 million gallons per year of the "highest quality biodiesel available in the United States". Their Website has useful comparison tables of biodiesel with conventional petrodiesel fuel.
http://www.griffinind.com/html/biodiesel.html

Comparison of Transport Fuels -- Final Report (EV45A/2/F3C) to the Australian Greenhouse Office on the Stage 2 study of Life-cycle Emissions Analysis of Alternative Fuels for Heavy Vehicles, by Tom Beer, Tim Grant, Geoff Morgan, Jack Lapszewicz, Peter Anyon, Jim Edwards, Peter Nelson, Harry Watson & David Williams -- CSIRO in association with The University of Melbourne, the Centre for Design at RMIT. Parsons Australia Pty Ltd and Southern Cross Institute of Health Research.
http://www.greenhouse.gov.au/transport/comparison/index.html
Part 1 provides a summary of the salient points of each fuel, Part 2 consists of detailed chapters on each fuel.
Executive Summary (Acrobat file 186Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/execsummary.pdf
Part 1 Biodiesel - (Acrobat file 36Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/1ch4.pdf
Part 2 Biodiesel - (Acrobat file 347Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/2ch4.pdf

Bibliography of Water-Fuel Emulsions Studies -- A list of studies that are being considered for inclusion in work being done by EPA to assess the effects of water-fuel emulsions on emissions of oxides of nitrogen (NOx), hydrocarbons (HC), and particulate matter (PM) (including 23 studies of diesel water-fuel emulsions). Acrobat file, 12kb.
http://www.epa.gov/otaq/models/analysis/emulsion/emulbibl.pdf

Emulsions of Hydrated Ethanol in Hydrocarbon Fuels, by Apace Research Ltd - Executive Summary of report for Australia's for the Energy Research and Development Corporation (ERDC) -- reports on hydrated ethanol/diesel fuel emulsion, or "diesohol", and hydrated ethanol/petrol emulsion.
http://www.eidn.com.au/energyerdcemulsions.htm

Government sources

The **US Government** has a maze of Websites dealing with alternative fuels, biofuels and biodiesel, offering useful information and resources. These are a good place to start:

The **US Department of Energy** has upgraded their website, so many

bookmarked documents may prove to be unavailable. General biofuels portal:
http://www.ott.doe.gov/biofuels/publications.html#biodiesel

Biofuels -- Document Database search:
http://www.ott.doe.gov/biofuels/document_database.html

"**Biodiesel Research Progress**", a summary of biodiesel studies from 1992 to 1997 can be found at:
http://www.ott.doe.gov/biofuels/pdfs/biodiesel_92-97.pdf
The document is primarily an index, serving as a springboard to points where respective research was conducted. Acrobat file, 302 pages, 824 kb -- alas, no hotlinked urls.

The **National Renewable Energy Laboratory** (NREL) is the U.S. Department of Energy's premier laboratory for renewable energy and energy efficiency research, development and deployment. NREL is operated for the U.S. Department of Energy by Midwest Research Institute,
http://www.nrel.gov/
NREL Search and Site Directory:
http://www.nrel.gov/search.html

The **Alternative Fuels Data Center** is a one-stop shop for all your alternative fuel and vehicle information needs. This site has more than 3,000 documents in its database, an interactive fuel station mapping system, listings of available alternative fuel vehicles, links to related Web sites, and much more.
http://www.afdc.doe.gov/
Alternative Fuels Data Center Document Search
http://www.afdc.nrel.gov/cgi-bin/doc_search/searchora.cgi
Alternative Fuels Data Center -- search the AFDC Web site:
http://www.afdc.nrel.gov/search.html

Search for biodiesel at the **Energy Efficiency and Renewable Energy Network** (EREN):
http://www.eren.doe.gov/menus/search.html
EREN's "Ask an Energy Expert"
http://www.eren.doe.gov/menus/energyex.html
where you can question a specialist at the Energy Efficiency and Renewable Energy Clearinghouse (EREC) by email.

Biofuels information from the **US Department of Agriculture** and the **Agricultural Research Service** (ARS) Biofuels Research Program -- main focus on biodiesel and ethanol: Production and Use of Biofuels, Production of Raw Materials (Crops), Economic Research, Market Research, Pros and Cons, Getting Started in Biofuels, Funding Opportunities, News and Events, Links.
http://www.nalusda.gov/ttic/biofuels/res.htm

Biodiesel Emissions Analysis -- the US Environmental Protection Agency

and the Office of Transportation & Air Quality **Biodiesel Emissions Database**, January 25, 2002 -- download as a 275kb Excel file or a 284kb Acrobat file.
http://www.epa.gov/otaq/models/biodsl.htm

Education

Biodiesel lesson plan from the **International Council of Associations for Science Education**, includes general information, lab experiments and research questions. Suitable for high school to undergraduate levels.
http://sunsite.anu.edu.au/icase/i_exemp1.html

U.S. Department of Energy Office of Transportation Technologies (OTT) **Kid's Page**
http://www.ott.doe.gov/kids.html
-- fun for boys and girls learning about alternative fuels and helping the environment. Stories and a coloring book, and lots of links to other energy education sites.

U.S. Department of Energy Office of Transportation Technologies (OTT) **Student Competitions** page
http://www.ott.doe.gov/student.html
-- multi-disciplinary projects for all grades and ages where students gain hands-on experience and learn why energy matters.

Useful education links and resources at the U.S. Department of Energy's Energy Efficiency and Renewable Energy Network (EREN) **Education and Training** site.
http://www.eren.doe.gov/education/

Energy Quiz -- from the Energy Information Administration, US Department of Energy: 15 multiple-choice questions with "Find the answer first or look at the Quick Answer List."
http://www.eia.doe.gov/kids/energyquiz.html

Biofuels

Biofuels Library
Biofuels supplies and suppliers

Biodiesel

Make your own biodiesel
Mike Pelly's recipe
Two-stage biodiesel process
FOOLPROOF biodiesel process
Biodiesel processors
Biodiesel in Hong Kong
Nitrogen Oxide emissions

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Biodiesel resources on the Web

Do diesels have a future?

Vegetable oil yields and characteristics

Bubble washing

Biodiesel and your vehicle

Food or fuel?

Straight vegetable oil as diesel fuel

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Ethanol resources on the Web

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Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

Ethanol
Ethanol resources on the Web
Is ethanol energy-efficient?

Home

Do diesels have a future?

An Oldsmobile diesel -- the notorious 5.7-litre 350 cubic inch GM diesel engine gave diesels a bad name in the US.

Should the "dirty diesels" be scrapped once and for all in favour of cleaner technologies? There are those who think so, especially in the US -- but maybe they just haven't been paying attention. There's no such confusion in Europe, for instance.

Diesel engines power 37% of all new cars sold in Europe (62% in France), with the share predicted to rise to 45% by 2005 -- but fewer than 1% of new American cars have diesel engines.

One reason is the poor quality of diesel fuel sold in the US. A 1998 report on fuel lubricity worldwide found that diesel fuel sold in the US and Canada is some of the poorest quality fuel in the world. Fully 50% of the US fuel was found to be below the standards recommended by equipment manufacturers.
http://www.biodiesel.org/pdf_files/Lubricity.PDF

Big Oil has dragged it's feet in cleaning up diesel fuel in the US. Europe started producing cleaner, low-sulfur diesel fuel in 1990; the US plans to follow in 2006. And the new generation of clean diesels either can't meet the US emissions standards on the dirty US fuel, or they can't even use it. But they run just fine on biodiesel, with very low emissions.

For a possible view of the future, we have to look to the past. The **Elsbett engine** -- the 3-cylinder SVO (Straight Vegetable Oil) diesel motor designed by the late Ludwig Elsbett, was a highly advanced true multifuel engine, and the forerunner of all DI diesels made today.

Details:
http://www.elsbett.com/gd/eteche.htm
More detail (in German):
http://www.elsbett.com/gd/etech.htm

News article about a Mercedes fitted with the amazing Elsbett engine (120kb graphic file).

Diesel motor development is very advancing rapidly, with tremendous improvements in efficiency, economy, performance and emissions -- but not, as yet, in the direction of true mutlifuel motors that can run on petroleum diesel fuel, biodiesel, SVO, or any combinatioin of the three without modification and under full manufacturer's warranty. This is what the fast-growing international biofuels community is pushing for.

Meanwhile, there are signs of change in increasing use of diesels in the US:

"**Panel tells EPA no technical problems getting sulfur out of diesel fuel**" -- Washington, Associated Press, October 30, 2002: There are no technical problems that should prevent refiners from producing nearly sulfur-free diesel by 2006 when new requirements for the cleaner fuel go into effect, an advisory panel told the Environmental Protection Agency. The report by an independent review panel, whose members included both oil industry representatives and environmental advocates, concluded "there are no technological impediments" to refineries reducing the amount of sulfur in diesel from the current 500 parts per million to 15 parts per million.
http://www.signonsandiego.com/news/science/20021030-1438-cleandiesel.html

What people are saying about us
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Eco-footprint

"**Clean-Air Czar of California Shifts to Accept Diesel Engines -- In Controversial Turn-Around, Regulator Sees Diesel as Alternative in Global-Warming Fight**" -- The Wall Street Journal, October 24, 2002: For years, Alan Lloyd has regarded diesel as a dirty word, synonymous with brown haze and cancer-causing black soot. It's a view he has shared with environmental activists across the U.S. But in a striking change of heart that could alter the kinds of cars and trucks Americans drive, the chairman of the powerful California Air Resources Board is taking a new look at diesel vehicles. He thinks they're poised to emerge as part of the solution to a different environmental problem that's gaining more attention in the U.S.: global warming... Here, diesel engines are the greener option because they don't pump out as much so-called greenhouse gas as gasoline engines do... Dr. Lloyd says he has concluded that a new generation of high-tech diesels developed for Europe bear little resemblance to the smoke-spewers that Americans remember from the 1970s and 1980s.
http://forums.biodieselnow.com/topic.asp?TOPIC_ID=294

See **Diesels in the US**

"**First Test: 2002 Ford Focus Tdci; Diesel-powered Pocket-rocket**" -- Motor Trend (August 2002): Ford's 1.8L turbo-powered Focus isn't sold in the United States. That could change. Oil-burning Foci like this one -- borrowed from Ford's Scientific Research Laboratory in Dearborn, Michigan -- have been wowing Europeans for a year. Future California emission laws for particulates and oxides of nitrogen are posing stiff problems for the lab types. They say they have catalysts and other solutions that'll work, but only if the sulfur content in U.S.-spec diesel fuel is substantially reduced.
http://www.motortrend.com/roadtests/wagon/112_0208_focus/index.html

"There is no argument anywhere in the auto industry that more low-sulfur diesel fuels are needed to help bring cleaner, advanced, direct-injection diesel engines to market in the United States." -- "**The Debate Over Diesel**", by Warren Brown, Washington Post, September 6, 2002
http://www.washingtonpost.com/ac2/wp-dyn?pagename=article&node=&contentId=A45702-2002Sep6&notFound=true

The Opel Eco-Speedster sports car prototype: The 1.3-litre Ecotec Diesel engine produces 112 hp, giving the car a maximum speed of more than 155 mph, and fuel consumption of 94 mpg (US), 2.5 liters per 100 km.
http://www.autointell.com/News-2002-October-2002/October-2002-1/October-02-02-p5.htm

"According to studies by both J.D. Power and Associates and the Diesel Technology Forum, roughly one third of Americans would consider a clean diesel, if given the option," says Kurt Liedtke, CEO of the Robert Bosch Corporation. He said by increasing diesel market share from one to 40%, the US will achieve $9 billion annual savings in oil consumption; average fuel economy of 28 miles per gallon (CAFE); greater independence from foreign oil sources; and 5 million metric ton decline in annual greenhouse gas emissions. -- "**Diesels Are Ready. Why Aren't We?**"
http://www.boschusa.com/News/ViewNews.asp?NewsType=PA&ID=0

See: **Diesel engine, as a "ready for use" energy saving technology** -- by Hakan Falk at ***Energy Saving Now***.
http://energy.saving.nu/biofuels/dieseltech.shtml

"Super Diesels!", Ward's Auto World, September 1, 2001
http://industryclick.com/magazinearticle.asp?magazineid=50&releaseid=8418&magazinearticleid=118355&siteid=26
"European policymakers have recognized the environmental advantages of diesel, and have allowed new diesel vehicles to prove themselves as efficient, quiet and powerful

School and youth programs on the Web
Education resources on the Web
Children's poetry

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alternatives. In America, growth in the market share of light-duty diesels would vastly reduce fuel consumption, foreign oil imports and greenhouse-gas emissions... Most interests in the auto industry -- in the US and abroad -- are beginning to wonder aloud if we, and the Bush Administration, do indeed have our priorities in order... With all things considered -- including customer-pleasing performance -- if the US ignores high-technology diesels in favor of its current fascination with HEV technology, we probably aren't backing the right horse...

"... PSA Peugeot Citroen has in production for the 607 HDI a silicon carbide honeycomb filter that accumulates particulate matter for between 200 and 300 miles (480 km), then the accumulated particulates are oxidized by injecting a small amount of fuel and a rare-earth-derived additive called Eolys to superheat the exhaust and burn off the particulates. The Eolys tank holds 1.3 gallons (5L) and requires refilling every 50,000 miles (80,000 km) or so. It is claimed to eliminate 95% of particulate emissions.

"Volkswagen AG is working on a novel 'engine-based' approach leveraging complex chemical and catalytic reactions to achieve the near-zero particulate emissions. And supplier and automaker R&D operations are running full-tilt to perfect prototype NOx-reduction technology like Toyota's promising Diesel Particulate-NOx Reduction (DPNR) catalyst, which also employs advanced chemical/catalytic processes to scrub out the last vestiges of diesel emissions nastiness..." (6,500-word article)

"Diesel engines could help US beat fuel crunch if feds wake up" -- Diesel engines, the hottest auto trend in Europe, are being regulated out of existence in the United States. -- Detroit News, 22 May, 2001
http://detnews.com:80/2001/autos/0105/22/b01-226787.htm

"Diesel will drive the 21st Century", says biodiesel fuel producer **Southern States Power Co**, reporting a worldwide change from petrol engines to "much more efficient" diesels. "The near-term future of transportation will be defined by new diesel technology."
http://www.sspowerco.com/

World's Fastest Pickup -- And It's A Diesel!
Gale Banks's Sidewinder pickup passed through the speed traps of the Bonneville Salt Flats at 222.139 mph on Oct. 19, 2002. Banks's Dodge Dakota is powered by a modified 2003 5.9-liter Cummins turbodiesel straight Six that produces 735 hp and more than 1300 ft.-lb. of torque.
http://popularmechanics.com/automotive/motor_sports/2002/11/worlds_fastest_pickup/
Gale Banks Engineering in Azusa, Calif.:
http://www.bankspower.com/Banks_Sidewinder/sidewinder-news.cfm

DieselNet's Diesel Emissions Online says the "diesel engine is the most efficient power plant among all known types of internal combustion engines", and discusses "the clean diesel engine of the future".
http://www.dieselnet.com/

Leading the way: Volkswagen 1-liter Concept

-- the world's first 1-liter car uses less than 1 litre per 100 km, 239 mpg. About the weight of a touring motorcycle (290 kg, 639 lb), the 1L seats two, has a single-cylinder 299cc diesel SDI motor, and does 120 kph -- 74 mph. Long, narrow and low-slung, it's a sporty car that's "fun to drive". It was designed in a wind-tunnel, and has the same standards of impact and overturning protection as a GT racing car. VW says it's suitable for everyday use and is "perhaps an indication of a totally new family of cars". The one-cylinder SDI engine has a 6-hole injection jet and pre-injection, two overhead camshafts and three valves, and high-tech lightweight construction, weighing only 38 kg (84 lbs)

including the starter-alternator.
http://www.vwvortex.com/news/index_1L.html
http://www.vwvortex.com/news/04_02/04_17/index.shtml

The diesel-powered **Volkswagen Lupo 3L TDi** is one of the most fuel-efficient cars in the world. It's called the "3L" because its official fuel consumption is below three litres per 100 km -- 94.1 miles per gallon. In 2000 a Lupo 3L went on a globe-trot. It covered 20,699 miles at an average speed of 53.1 mph on daily journeys of between 76 and 478 miles and used only 174.7 gallons of diesel -- an average of 118 miles to the gallon. The best fuel consumption recorded was 141.9 mpg, the worst 100.9 mpg. The Lupo 3L TDi is powered by a 1.2-litre 61bhp three-cylinder diesel engine with direct fuel injection. See "Volkswagen Lupo's record attempt in Australia":
http://www.autoweb.com.au/start_15/showall_/id_VWN/doc_vwg0006011/article.html
"Lupo 3L TDi Back In Wolfsburg":
http://www.diskdrive.co.za/newsstories/vw_lupo3ltdi.html
The Lupo also broke the round-Britain economy record, previously held by a standard Japanese Daihatsu Charade diesel at 103 mpg. Volkswagen engineers are working on a super-economical motor that could go 300 miles on only one gallon of fuel.

Volkswagen's 4-cyl. **Golf GTI TDI 150** diesel blows away a lot of sporting cars, propelled by the most satisfying aspect of engine performance -- torque. More torque than a V-6 Jaguar. Diesels have torque in spades. The TDI 150 gets 40 mpg (5.9 L/100 km) and goes from 0-to-62 mph (100-km/h) in 8.5 seconds. Diesel power stormed from 14% of European new-car sales in 1990 to 33% last year, and they're expected to hit 50% by 2010. (From "Super Diesels!", Ward's Auto World, September 1, 2001)

It Gets 78 Miles a Gallon, but U.S. Snubs Diesel, New York Times, Frankfurt, May 26, 2001 -- To judge by the mileage it can get, the Audi A2 sounds like just the kind of exotic hybrid-fuel car that President Bush would want to promote with his new energy plan. The sporty new four-door compact has a top speed of 100 miles an hour. It can travel 78 miles on a single gallon of fuel and emits fewer "greenhouse" gases than almost any other vehicle on the market. Yet the A2 has at its core a technology that generates scorn in the United States: the diesel engine. Diesel engines powered 32.3 percent, or nearly one-third, of all new cars sold in Europe last year, compared with 21.7 percent in 1997. Analysts predict the share will rise to at least 40 percent by 2005. The contrast with the United States could not be more stark. Fewer than 1 percent of new American cars have diesel engines.
http://www.nytimes.com/2001/05/27/business/27DIES.html

"More Focus on Diesel", Sacramento Bee, June 1, 2001 -- In Europe, one of every three new cars sold today is powered by clean diesel technology and in the premium and luxury categories, over 70% are clean diesels. But in the US, light-duty diesels account for only about 0.26% of all new cars sold, with only slightly higher figures in the light-duty truck markets. It's completely understandable why clean diesel technology has such a high acceptance in Europe -- the engines provide more power, are more fuel efficient, are more durable, are extremely responsive with low-end torque, and have 30-60% lower greenhouse gas emissions.
http://www.dieselforum.org/news/aug_06_2001.html
Sacramento Bee
http://www.sacbee.com/

"Demand for Diesels: The European Experience -- Harnessing Diesel Innovation for Passenger Vehicle Fuel Efficiency and Emissions

Objectives", Diesel Technology Forum (Acrobat file)
http://www.dieselforum.org/whitepaper/downloads/EuropeanExperience.pdf

"GM pushes diesel revival" -- Automakers say new engines are cleaner, more fuel efficient. -- Detroit News, 21 May, 2001
http://detnews.com:80/2001/autos/0105/22/a01-226651.htm

"Diesel Engines Get Spotlight in Fuel-Efficiency Contest" -- New York Times, June 12, 2001
http://www.nytimes.com/2001/06/12/business/12DIES.html

Automakers see potential in diesel, Detroit Free Press, March 5, 2002 -- The diesel engine may have gone out of favor with the U.S. public in the early 1980s, but automakers, faced with increasing regulatory demands for fuel efficiency, are trying to bring it back in vogue. The 2002 Society of Automotive Engineers World Congress was the scene of a lovefest for the inclusion of diesel technology in the discussion of fuel economy and the future of the auto industry. "Modern diesel technology can answer many of the needs of our society," said Nick Scheele, chief operating officer at Ford Motor Co.
http://www.auto.com/industry/diesel5_20020305.htm

The US government/industry collaboration **Partnership for a New Generation of Vehicles** (PNGV), launched in 1993, was intended to reduce carbon dioxide emissions by developing ultra-clean, 80 miles-per-gallon (34 km/litre) "hypercars" without sacrificing comfort, safety or performance, focusing on cleaner and more efficient diesel engines. Details:
Technology Administration: Partnership for a New Generation of Vehicles
http://www.ta.doc.gov/PNGV-Archive/default.htm
Hybrid Electric Vehicles: Program Background
http://www.ott.doe.gov/hev/background.html
Hybrid Electric Vehicles: Related Links
http://www.ott.doe.gov/hev/related.html
Hybrid Electric Vehicles
http://www.ott.doe.gov/hev/

The GM Precept -- 80mpg with super-clean diesel-electric power

General Motors' Precept achieved the mileage goal -- 80 miles per gallon. The car won the Popular Science "Best of What's New" Grand Award for automotive technology for 2000. The full-size five-passenger sedan is powered by two electric motors and a high-efficiency diesel. Its drag coefficient is just 0.16. GM says the Precept marks the leading edge of technology, and its design will have a strong influence on future cars. See **General Motors' Precept Delivers on 80-mpg Promise**:
http://gm.com/company/gmability/environment/gm_and_the_env/releases/overview_release_10xx00.html

Dodge ESX3

Chrysler's stylish Dodge ESX3 lightweight diesel-electric hybrid, part of the PNGV program, combines a direct-injection diesel with an electric motor and an advanced battery to achieve 72 miles per gallon (30 km/litre). The 5-seater body is made of thermoplastic -- the same cheap plastic used to make soft-drink bottles. Carbon dioxide emissions are 56% lower than a conventional petrol engine, with 50% less particulate matter than a conventional diesel and 70% less nitrogen oxides. Range is 420 miles (672 km). Unlike totally electric vehicles, hybrids have unlimited driving range and never need to be plugged in for recharging. See **DaimlerChrysler unveils electric car**:
http://detnews.com/2000/autos/0002/23/02230070.htm

Ford's bid for the car of the future is the P2000 Prodigy 5-seater sedan, an ultra-light diesel-electric hybrid that boosts fuel economy to 63 miles per gallon (27 km/litre) and was expected to qualify as an ultra low emissions vehicle. Part of the PNGV program. The 1.2 litre, direct injection diesel DIATA engine is 35% more efficient than an equivalent petrol engine. "Extremely fuel-efficient", and "A giant advance toward the production of lightweight, environmentally responsible vehicles with outstanding economy and emissions levels". See **Ford Hybrid Electric Vehicle is on horizon**:
http://www.autoworld.com/news/Ford/Ford_Hybrid.htm

The costs of the new hypercars came right down from that of the earlier prototypes, but were still higher than production models. See **Super-High-Mileage Car Just a Concept, For Now**, Washington Post, August 17, 2001:
http://washingtonpost.com:80/wp-dyn/articles/A25087-2001Aug17.html

Early in 2002 the PNGV program was axed by the Bush administration, to be replaced with the "Freedom Car" program focusing on hydrogen fuel-cells -- not expected to produce tangible results for a decade. See **Driving In Circles: New Fuel-Efficiency Initiative Is More PR Than Progress**:
http://www.tompaine.com/feature.cfm?ID=4959

It's An ENIGMA, EV World, March 3, 2002 -- Who said you can't build a parallel hybrid with 20 miles ZEV range? Not the team at San Diego State University. A remarkable story of ingenuity, vision and determination that lead to the creation of San Diego State University's 80 mpg Enigma diesel-electric hybrid sports car, running on biodiesel.
http://evworld.com/databases/storybuilder.cfm?storyid=312
San Diego State University College of Engineering Hybrid Electric Vehicle Team:
http://www.engineering.sdsu.edu/~hev/text.html

JetCar Version 2.5 -- The latest upgrade of the tandem, two passenger JetCar from Germany looks like a fighter but acts like a sailplane, sipping 2.1L/100 km of diesel fuel.
http://www.evworld.com/databases/storybuilder.cfm?storyid=573
In German and English:
http://www.jetcar.de

Next-generation ultra-clean diesel engine -- "Pointing the Way to the Future of the Automobile": This Isuzu engine more than clears stringent domestic and international diesel engine exhaust emission standards, putting this low-emissions powerplant in the same class as future eco-friendly gasoline engines... This translates into a dramatic, simultaneous reduction of particulate matter (PM) and nitrous oxides (NOx). The DPF and NOx catalytic after treatment assures even further reduction in emissions to alleviate environmental impact.
http://www.isuzu.co.jp/world/tms2001/engine.htm

The **BMW Alpina D10 Biturbo** is claimed to be the fastest production diesel in the world with the best acceleration -- top speed is 254 km/h (touring: 251 km/h) or 159 mph (touring: 157 mph).
http://www.alpina.de/english/automobiles/d10/d10_biturbo_e.htm

Onward March of Economical Diesels Is Unstoppable, Frankfurter Allgemeine Zeitung, Mar. 13, 2002 -- Diesel engines have become fashionable and,

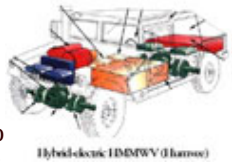
thanks to the dedicated progress made on direct injection, are now outstripping gasoline engines in the high-tech stakes. They have also become winners in the luxury segment, enjoying widespread popularity among men and women alike.
http://www.faz.com/IN/INtemplates/eFAZ/archive.asp?doc={58CEF733-A86D-4C4E-87A7-98A5B2937888}&width=800&height=580&agt=netscape&ver=5&svr=5

Peugeot moves to gain green edge, The Guardian, February 20, 2002 -- PSA Peugeot Citroën, Europe's second largest motor manufacturer, is hoping to steal a march on rivals by bringing in the "greenest" diesel engines. The cars will be introduced to the British and European markets next year -- two years before the stringent new regulations on emissions known as Euro IV are due to become law. "This will mean diesel offers a real alternative to consumers as it removes any lingering concerns about particulate issues and capitalises on the fuel consumption and CO2 emission benefits of diesel technology," said Al Clarke of the Society of Motor Manufacturers and Traders.
http://www.guardian.co.uk/business/story/0,3604,653071,00.html
1.4 HDi Peugeot 206: "You would never know it was a diesel," said a British reviewer. "There was no smoke or rattle, just eager performance and a slick gear change, and most incredibly of all, a low fuel consumption of 73.3 mpg."

The **V6 diesel S-Type Jaguar**, due for the showrooms in 2004, has a premium-class 2.7-litre V6 common-rail engine diesel engine developed by Ford/PSA Peugeot-Citroen to challenge BMW, Mercedes-Benz and Audi. The new V6 is the industry-first engine built using compacted graphite iron (CGI) technology instead of the conventional cast iron block. Peugeot and Citroen models (including the 807 and C8) will follow, and probably Land Rover and Volvo.
http://www.tiscali.co.uk/motoring/firstimp/2003/06/09/story_1.html

"**IEA Study Sees Clean-diesel As Low-cost, Rational Urban Transportation Strategy**" -- World Fuels Today (August 19, 2002) Harrisburg, PA: The International Energy Agency (IEA) this month will release a new study, "Bus Systems for the Future", recommending a more rational approach to urban transport and emissions reduction. Clean-diesel gets a high rating. Rather than pushing high-cost, knee-jerk schemes such as compressed natural gas (CNG) buses or high-cost Metro subways as the supposedly "green" universal solution to urban transport problems, IEA's exhaustive study instead finds that cities should take a more cost-effective 'technology ladder" approach to solving clean urban transport problems. The study takes note of the side-by-side cost comparisons done by big transit agencies with lots of real world experience, such as Los Angeles, New York and Paris. These agencies all find that clean-diesel is far more cost-effective than CNG.
http://www.greendieseltechnology.com/news140.html
"**Bus Systems for the Future, Achieving Sustainable Transport Worldwide**" 188 pp. (61 02 1 P1) ISBN 92-64-19806-7, Price $US 100 ¤ 110
http://www.iea.org/public/studies/bus.htm

http://www.lmcontrolsystems.com/PowerDrive.htm
Lockheed Martin's revolutionary HybriDrive diesel-electric hybrid engine for heavy-duty vehicles -- including urban buses and army trucks -- cuts emissions and fuel consumption. It accelerates faster and smoother and runs quieter than a conventional diesel. "This system is capable of significantly reducing emissions, while improving performance and reducing maintenance costs." See:
http://caddet-ee.org/newsdesk/nw398_02.htm



The **US Army's** hybrid diesel-electric "stealth" Humvee moves silently, uses much less fuel than its conventional diesel predecessor and accelerates like a sports car. The vehicle has four 100 hp UQM Technologies permanent magnet motors to provide power to each wheel and a fifth as a generator on the diesel powerplant. It has twice the acceleration and climbing capability of a conventionally powered Hummer. And, like a tank, it can turn around in place by having one or more wheels turn in different directions.
http://www.uqm.com/Technologies/programs/hummer.html

General Motors will produce a full-size pickup truck featuring a hybrid powertrain beginning in 2004. GM full-size hybrid pickup trucks, versions of the popular Chevrolet Silverado and GMC Sierra, will deliver top performance with nearly 15% better fuel economy. GM and its Allison Transmission Division will begin delivery this year of a "hybrid" powertrain for transit buses. The hybrid bus powertrain was designed and developed by GM Allison Transmission Division based in Indianapolis. The GM Allison system will offer 50% better fuel economy compared with a conventional diesel-engine transit bus. The system also will cut nitrous oxide emissions by 50%, while cutting particulate, hydrocarbon and carbon monoxide emissions by 90%, when fueled with low-sulfur fuel -- or, better, with biodiesel.
http://www.evaa.org/Newsmenu/News_Releases/PR080200/pr080200.html

Green Diesel Technology Vehicles Meet EPA Rule For Cleaner Diesel Trucks And Buses -- International and Engine Corporation, July 27, 2001: EPA Deputy Administrator Linda Fisher today recognized the recent certification of International Truck and Engine Corporation for its Green Diesel Technology school buses to be used in California. With this certification the corporation has demonstrated that it is possible to meet the heavy-duty diesel particulate emission standards well in advance of the 2007 model year requirements.
http://www.greendieseltechnology.com/news83.html

The **General Motors Duramax** is a lightweight and fuel-efficient engine that signals a new era in light truck design. The turbocharged 6.7-liter engine, the world's most powerful diesel, produces 300 horsepower and 520 pound-feet of torque, which makes towing a cinch. The direct-injection engine runs so smoothly that it's nearly free of diesel clatter. It is available in the new Chevrolet Silverado and GMC Sierra 3500-series pickups.
http://www.generalmotors.com/company/news_events/events/chicago00/e/concept/terradyne/function.htm

Isuzu Motors will launch a small hybrid truck in 2002. The truck, a two-ton capacity model based on the Isuzu Elf, will be powered by an electric motor and a diesel engine. By using a hybrid-propulsion system, Isuzu hopes to lower emissions, particularly carbon dioxide, and increase fuel-efficiency. Isuzu will share the hybrid technology with General Motors, which owns a 49% stake in Isuzu.

BMW to buy Toyota engines -- Tokyo, September 14, 2001: German luxury carmaker BMW has reached a basic agreement with Toyota Motor Corp to buy up to 30,000 diesel engines a year from Japan's biggest automaker.
http://www.planetark.org/dailynewsstory.cfm/newsid/12401/story.htm

Isuzu to make diesel engines for Renault -- Tokyo, August 30, 2001: Japan's Isuzu Motors Ltd will supply French automaker Renault SA with three-litre direct fuel injection diesel engines from the start of next year. Renault confirmed that it would outsource production of the engines for use in its Versatis luxury cars due out around the end of the year. Isuzu would supply between 10,000 and 20,000 engines a year for use in Renault's luxury car, capitalising on its expertise in the use of aluminium parts to make the three-litre engines lighter and more efficient.
http://www.planetark.org/dailynewsstory.cfm/newsid/12215/story.htm

Daimler, Mitsubishi to make eco-friendly engines -- Tokyo, August 8, 2001: Auto giant DaimlerChrysler and its Japanese partner Mitsubishi Motors Corp will

jointly develop environmentally friendly diesel engines for medium-sized to large trucks. DaimlerChrysler aims to cut costs and save time in developing diesel engines to meet tightening global emissions standards. Together, the two companies produce 370,000 buses and trucks every year, the most in the world. The venture could also include South Korea's Hyundai Motors.
http://www.planetark.org/dailynewsstory.cfm?newsid=11935

See also **Diesel motorbikes**

Old diesels

But what about the millions of existing "old-tech" diesel vehicles that power the world's transport fleets? Converting them to the clean, new technology will be a slow and costly process -- and meanwhile they'll continue belching clouds of poisons from their exhausts.

But diesels are by far the most economical and efficient engines, and the world's transport industries rely on them. Scrapping the diesels would raise the costs of just about everything and make everyone's life tougher.

This is where biodiesel and other clean fuels have a role to play -- biodiesel can cut diesel emissions now, at no extra cost, and without having to do anything except put it in the tank.

US biodiesel producer **Southern States Power Co** (SSPC) demonstrated biodiesel to Mexico's EPA in January 1999 using an aging 1972 diesel truck that belched black smoke -- typical of the many old heavy-duty trucks in Mexico City. "When the biodiesel fuel reached the engine, the exhaust became clear with no black smoke." The results were "nearly identical to results obtained by the US federal government using similar blends of soybean oil and regular diesel fuel".
http://www.sspowerco.com/

Meanwhile, the **Environmental Protection Agency** in the US plans to lower the sulfur levels in diesel fuel from the current 500 parts per million (ppm) to less than 15 ppm. But this will destroy the lubricity of the fuel -- important in diesel engines because diesel engine parts are lubricated by the fuel itself. Only the newest motors will be able to use the new ultra-low-sulfur fuel. This is an opportunity for biodiesel, says executive director of the US National Biodiesel Board Joe Jobe. "Biodiesel is an excellent lubricity additive. Adding one percent biodiesel improves the lubricity up to 65 percent." And biodiesel contains no sulfur. See Biodiesel Development Corporation -- Biodiesel: Cost Effective Lubricity Enhancer:
http://pipeline.to/biodiesel/

Quotes

"Diesel engines today are 500% cleaner than they were just 20 years ago."-- Chrysler

"Pollution from diesel cars has been cut by 80 to 90% over the past two decades."-- Union of Concerned Scientists

"Particulate emissions from diesel-fuelled engines have been reduced by 90% over the past decade." -- Engine Manufacturers Association

"Direct injection diesel four-stroke engines add up to 12 miles per gallon (5 km/litre) -- or 24% increased efficiency -- over gasoline engines in a large car." -- Chrysler

"Compared to a gasoline engine, a direct injected diesel engine reduces carbon dioxide emissions by as much as 56%." -- Chrysler

"Today's best diesel passenger vehicles are more efficient than their gasoline counterparts, reducing carbon emissions by roughly 30%." -- Union of Concerned Scientists

"The most significant challenge is nitrogen oxides and particulate emissions. Future diesel engines will have to be four to eight times cleaner than they are today." -- Chrysler

"Pollution from diesel cars must be reduced another 75 to 90% within the next few years." -- Union of Concerned Scientists

"Current (PNGV) design criteria call for an 80% reduction in nitrogen oxide emissions compared to current diesels, and a 50% reduction in particulate emissions. This is well beyond current regulatory requirements." -- former US Vice President Al Gore

"Compression-ignition (diesel) direct-injection engines potentially meet regulatory requirements for emissions while maintaining their traditional advantages of reliability, high efficiency, durability, and competitive cost." -- US Partnership for a New Generation of Vehicles (PNGV)

Rudolf Diesel invented the diesel engine 108 years ago for reasons that would now be called appropriate technology: he conceived it as "a facility, readily adaptable in size and costs and utilizing locally available fuels, to enable independent craftsmen and artisans better to endure the powered competition of large industries that then virtually monopolized the predominant power source -- the oversized, expensive, fuel-wasting steam engine". The original diesel engines ran on vegetable oil (hemp seed and peanut oil). See Rudolf Diesel -- National Inventors Hall of Fame: http://www.invent.org/hall_of_fame/42.html

The clean diesels of the future will also run on vegetable oil.

"The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become in the course of time as important as petroleum and coal tar products of the present time."
-- Rudolph Diesel, 1912

There are still those who claim **diesels are outdated technology**. Read about what happened to one of them.

See also **The best car in the world**

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Make your own biodiesel
Mike Pelly's recipe
Two-stage biodiesel process
FOOLPROOF biodiesel process
Biodiesel processors
Biodiesel in Hong Kong
Nitrogen Oxide emissions
Glycerine
Biodiesel resources on the Web
Do diesels have a future?
Vegetable oil yields and characteristics
Bubble washing
Biodiesel and your vehicle
Food or fuel?
Straight vegetable oil as diesel fuel

Ethanol
Ethanol resources on the Web

Is ethanol energy-efficient?

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Do diesels have a future?
Vegetable oil yields and characteristics
Bubble washing

Are diesels "old technology"?

There was an argument about it on the **Biofuels mailing list**. **Superboost** started it when he wrote:

"Well, seems like I am getting nothing out of this group, except how little you all care about the devastating future we are about to live through. The following are my reasons:

1) Diesel in any form is a high source of pollution.

2) Burning diesel is more inefficient than burning gasoline because: a) the higher compression ratio robs power b) more (a lot more) of the fuel's energy is wasted as heat, thus less energy is left to push piston.

3) Biodiesel production is about as bad as burning petrodiesel--fumes from the brew would replace the pollution cut back by burning biodiesel

4) No matter how bad you want it to stop, diesel will always destroy its engine faster than one running on gasoline

5) The increased volume of oil needed in the crankcase poses another environmental hazard.

6) The diesel engine is noisy as hell. And I thought this being the 21st century we could have quiet sources of energy.

Now, is there anyone here who would like to list advantages of the diesel? The first one would be what, that no spark is needed? Well, OK good, but a high-pressure pump is needed, plus a turbo to get the same power out of it as a gasoline engine with no turbo. Think about it...

PS. I apologize if anyone is "offended" by this message, but these are the views of those of us who want to actually have a cleaner planet."

This annoyed **Steve**:

"All you have done is prove you know absolutely nothing about engines, fuels, or efficiency. Your arguments are so wrong, that I

Biodiesel and your vehicle
Food or fuel?
Straight vegetable oil as diesel fuel

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

Ethanol
Ethanol resources on the Web
Is ethanol energy-efficient?

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What people are saying about us
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Composting
The Wheel of Life
Small farms
The way forward
Biofuels
Fuel for the future
Solar box cookers
Sun power saves lives and trees

don't know where to begin refuting them, so I'll pass. Please go away."

From **Bryan**:

"I'll give you a hint. Always start at the beginning no matter how daunting the task. <g>"

Bryan took his own advice:

">Well, seems like I am getting nothing out of this group, except how little you all care about the devastating future we are about to live through. The following are my reasons:

Now I can't help but think you missed something somewhere. See this is the biofuel egroup. Here we talk about the fuels we have to have today to get our rig down the road and how best to make those fuels be kinder to the planet. It is not the anti-fuel egroup or the fly for free on magnets group. Everyone here recognizes that in our current society we depend on fuels to get around.

>1) Diesel in any form is a high source of pollution.

Some higher then others.

>2) Burning diesel is more inefficient than burning gasoline because: a) the higher compression ratio robs power b) more (a lot more) of the fuel's energy is wasted as heat, thus less energy is left to push piston.

That's why I get double the mileage out of a 6.5? My Dad has a Ford 460 in his '79 Van that gets him 10 miles to the gallon (when he is lucky) I get 20 MPG on a fair day, 23 on a good day and about 18/19 on a bad day. I also have just as much power as he does..

>3) Biodiesel production is about as bad as burning petrodiesel--fumes from the brew would replace the pollution cut back by burning biodiesel

We use some nasty stuff. Waste vegetable oil is considered hazardous waste. When we get done we take the hazard out of it and use it for fuel. When our "brew" is finished we have nothing really hazardous left. Basically soap and bio-diesel.

>4) No matter how bad you want it to stop, diesel will always destroy its engine faster than one running on gasoline

Trees, soil and water
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What works and fits
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School and youth programs on the Web
Education resources on the Web
Children's poetry

Semi-Trucks work their engines a lot harder then the rest of us ever do. The owner operator I used to work for used to retire his trucks after they hit 3 million miles. Now why don't they use gas if everything you say is true?

>5) The increased volume of oil needed in the crankcase poses another environmental hazard.

Very small. Ever hear of recycling?

>6) The diesel engine is noisy as hell. And I thought this being the 21st century we could have quiet sources of energy.

And I like it that way. That's how I know it is well and strong. If it suddenly gets quiet on you then something messed up the timing. Of course that is on older rigs and I have no muffler on mine as well. Some newer rigs are pretty quiet compared to older ones.

>Now, is there anyone here who would like to list advantages of the diesel? The first one would be what, that no spark is needed? Well, OK good, but a high-pressure pump is needed, plus a turbo to get the same power out of it as a gasoline engine with no turbo. Think about it...

So what have you got against turbos? They are great and they increase the efficiency of the engine. It has got to be one of the better inventions related to the cumbustion engine.

P.S. I am not offended whatsoever because it is obvious you have no idea what this e-group is about or what you are talking about."

Skaar had this to say:

" Diesel trains are diesel electric, the newer crop of cars being shoved out of the plants work on the same principle, use enough fuel to charge some batteries, then run off an electric motor. 'Course the cars also have transaxles to use both occasionally. So running a diesel-electric car, house, etc, has definite advantages.

>1) Diesel in any form is a high source of pollution.

Biodiesel seems to cut back on pollution by making it almost environmentally sound, with engine conversion straight cooker oil can be used.

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>2) Burning diesel is more inefficient than burning gasoline because: a) the higher compression ratio robs power b) more (a lot more) of the fuel's energy is wasted as heat, thus less energy is left to push piston.

So use the waste heat for something, and are you sure?

>3) Biodiesel production is about as bad as burning petrodiesel--fumes from the brew would replace the pollution cut back by burning biodiesel

Back to 1.

>4) No matter how bad you want it to stop, diesel will always destroy its engine faster than one running on gasoline

I doubt it, have you got some stats? We'd all like to know if we are wasting our time.

>5) The increased volume of oil needed in the crankcase poses another environmental hazard.

Only in a crash, but what are the crash statistics? Trucks only get attention when they crash, they don't crash all that much really. And the hefty block would give better crumple protection.

>6) The diesel engine is noisy as hell. And I thought this being the 21st century we could have quiet sources of energy.

OK, transports are very noisy, but the newer VW diesels are quiet because of some good design and lots of sound insulation, still means earplugs needed to stick yer head under the hood. Does most of the noise come from the turbo or the exhaust, switch to supercharger, add some harmonically tuned pipes.

I'm guessing you ragged on the guys cause you wanted to get 'em yakkin, please be less inflammatory, it gives me gas."

And asked:

"Do you think I've done a good job refuting his disagreement, won't call it an argument, not intelligently enough written."

Bryan answered:

"I did a better job, I think. But I really liked yours too and yours was funny. Keep it up."

Steve relented:

"OK, you persuaded me.

Number 1. Diesel is less polluting than gasoline with MTBE, but is still a major source of pollution. Biodiesel eliminates all but the NOx.

Number 2 is laughable, it's the high compression that produces the greatest power. And diesels are more efficient because they run hotter.

Number 3 is ludicrous, especially with ethanol base instead of methanol. The fumes aren't polluting, just dangerous in an enclosed space.

Number 4 is nonsensical, since diesels get close to a million miles at times, where gas engines are often worn out before 200,000.

Number 5 is mitigated if using bio-based oils.

Number 6 isn't as true as it used to be, many diesels are fairly quiet, and could be quieter with sound deadening materials. I had a gas truck that knocked more than my diesel rabbit.

The advantages of a diesel engine? More torque, better fuel efficiency, longer life, less electronics (or none) needed, can run on a bio-based fuel with no modifications."

Bryan accepted defeat:

"OK you win! That was a good job, better then mine, but maybe that was because I forgot what MTBE stands for. You reminded me of course that my engine is quite a bit quieter when I run it on biodiesel."

Then **Stephen** wrote:

"Diesel is a very efficient engine and can run on many fuels, such as methanol, diesel oil, biodiesel, vegetable oil, methane, ethanol blends, and other blends. There was no petrol when Rudolf Diesel invented his engine. The first diesels ran on wood alcohol, as did the first autos. Oil was discovered over 20 years later.

A diesel kept in good condition and tuned properly is less polluting then a gasoline engine. The average gasoline auto puts out about 12,000 lbs of pollutants a year. About 7,500lbs of gasoline and 4,500lbs of air. The average heavy diesel truck puts out about 60,000lbs a year. But it would take 100 or more autos to transport the same amount of goods as one big diesel truck. Which is more efficient?

High compression does not "rob power", once the diesel is started it runs itself very nicely, and will pull whatever weight it was designed for. 80,000lbs for big doubles here in the US, maybe more down under. Diesel fuel burns, almost all of its energy is used to push the pistons down a long stroke burning all the way. Gasoline explodes, knocking the piston down a short stroke and exhausted, so most of the gasoline and its heat are wasted. It takes about 4 units of energy to produce one unit of gasoline. It takes about 1.8 units of energy to produce one unit of diesel. According to the Department of Energy, it takes one unit of energy to produce 3.75 units of biodiesel energy from existing waste oils and grease.

You say diesel will destroy an engine faster than a gasoline engine? Get your head out of the sand. Diesel burns. Gasoline explodes. I know engines, I know how and why they wear. I know how long an engine will last if properly maintained, and properly used. I have never seen a gasoline engine last longer than a diesel which was not abused.

As for oil in the crankcase? What's the problem? Crank oil has been refined and reused for over two centuries. Whale oil was used before petrol.

Old technology? Everything is "old", all we are doing is transforming what is already here. Trying to make the transitions more compatible to our way of life and enviromentally friendly. While the richer countries do slowly change, 3/4 of the world will not. They cannot afford the necessary investment, trying to feed and educate their people is utilizing all their available resourses. A worldwide effort is needed. Affordable small family units are needed, ie: stills, digesters, solar, wind power, etc. Instead of putting things down, channel your energy into inventing a small affordable family unit, a better way, something practical for everyone.

Would you have 200 autos and mini vans replace one big double diesel truck? Do the math, 200 gasoline engines times 12,000lbs of pollutants or one diesel with 60,000lbs of pollutants each

driven the same distance."

John added this:

"Still one important point that hasn't been given enough weight in the current debate I feel.

Fossil fuel is carbon that has been locked up for eons and doesn't need to be re-released into a world of increasing carbon emmissions. Biofuel rehashes carbon that is in a free form in the environment at present and as such has very little effect on current atmospheric carbon ratios provided the efficiencies are as they appear to be.

I'm all for leaving the old carbon where it is and trusting the current swamp ecosystems are still doing the job they did to lock up the carbon reserves back when the atmosphere was even less breathable than today.

And then just maybe someone can come up with a turbo or burn that leaves a little more of the atmospheric nitrogen out of the current power stroke and NOx emmissions will also fall."

And **Skaar** commented:

"Of course there's carcinogens in diesel fumes, but there's less than in gasoline exhaust, partly because of the combustion method. Almost everything burned produces carcinogens, wood, propane, fossil oils, there are few that don't. Since in this group we are using or are going to use fuels that don't have these problems, who cares if diesel is outlawed? The people who can make biofuels will be the new gurus in this barren wasteland, like those people in the *Road Warrior* that had their own refinery, but much more willing to share."

Nothing further was heard from **Superboost**.

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Diesel motorbikes

A classic goes diesel: **Royal Enfield** Motors of India still makes these classic British bikes, and exports them to more than 20 countries, including Japan, the USA, Canada, France, Germany -- and Britain. And these days they make diesel versions. Email intlbusiness@royalenfield.com
http://www.royalenfield.com/

"Royal Enfield -- Made like a gun, goes like a bullet" -- Berlin Enfield dealer **Pig7** exports the Enfield Diesel 325 and Diesel 435: 1,000 km on a tankful.
http://www.pig7.de/enfield.htm

Royal Enfield Lightning Diesel 435 with E-Starter
http://home.t-online.de/home/Beckedorf/gesp~1.htm

Royal Enfield Taurus diesel, from Iwan-Bikes of Germany
http://www.iwan-bikes.de/EnfDiesel.html

Above left: Royal Enfield **Taurus** diesel. Above right: Indian-made Royal Enfield Bullet fitted with a German made 350cc direct injection **HATZ Diesel** engine. New bikes retail at £3995 from Charnwood Classic Restorations in the UK. Email Sales@charnwoodclassic.com
See: http://www.peace65.freeserve.co.uk/Pictures/diesel.htm
And: http://www.peace65.freeserve.co.uk/Pictures/diesel2.htm
Lots of diesel bikes at this site! And lots more here:
http://www.peace65.freeserve.co.uk/Pictures/royalenfield.htm

Rolex Impex Co, India, claims to be the largest exporter of Royal

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Healthcare for mountains
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Enfield motorcycles from India. Contact: Pravin Thakkar, ROLEX IMPEX CO, A/3/2, Groma House, Sector 19, Vashi, Navi Mumbai 400705, India. Phone +9122 27895433 Fax +9122 27895439. Email: "THAKKAR" <rolex@bom4.vsnl.net.in>
http://www.roleximpex.com/

MZ Robin diesel motorbike with Variomatic automatic transmission; only 10 were ever made -- 3-page article from **Motorcycle Sport and Leisure**, August 1997; page 3 features the **DERA** army prototype (above right) for NATO's all-diesel strategy.
http://www.angelfire.com/wi/williamhogervorst/images/page1.jpg
http://www.angelfire.com/wi/williamhogervorst/images/page002.jpg
http://www.angelfire.com/wi/williamhogervorst/images/page003.jpg

Unveiled in May 2001, the **M1030M1** is claimed to be the world's first diesel-powered motorcycle designed specifically for military use. It is derived from a stock Kawasaki KLR650, and has been developed jointly by Californian firm Hayes Diversified Technologies and Britain's Royal Military College of Science. It is intended for the British and US military and for NATO. The 580cc diesel engine boasts a 50% improvement in fuel consumption over petrol-engined equivalents, lower emissions, and better cross-country utility. It gets 120 miles per gallon, the engine develops 33ft/lb of torque and the bike has a top speed of 85 mph.
Description, more pictures (Acrobat file, 164Kb):
http://www.peace65.freeserve.co.uk/Pictures/MDIESHDT3.pdf
Specifications (Acrobat file, 26Kb):
http://www.peace65.freeserve.co.uk/Pictures/M1030M1%20spec-3.pdf
The M1030M1 diesel-powered motorcycle put through its paces at a recent demonstration in Chertsey organised by the UK Defence

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Handmade Projects
Ichijima
Japan

Procurement Agency -- view the video (RealPlayer):
http://www.janes.com:8080/ramgen/janescom/diesel_mc.smi

Dnepr-Hatz Diesel

The unstoppable Dnepr MT11 motorcycle-sidecar combination from the Kiev Motorcycle Factory in the Ukraine -- fitted with a blower-cooled 2-cylinder 1000cc Hatz Diesel engine in place of the original 650cc horizontal twin BMW lookalike, and a specially strengthened frame. Available from 2002.
http://www.loew-gmbh.de/hatz.htm
Bavarian-Russian motorcycle hospital -- LOEW GmbH in Germany
Email: loew@tronicplanet.de
http://www.loew-gmbh.de
Test report in the German magazine **Motorrad Gespanne**:
http://www.loew-gmbh.de/mg.htm
Hatz Diesel:
http://www.hatz.com/
More about the amazing Dnepr -- "No other civilian bike in the world comes close to doing what a Dnepr can do." Russian-American Motorbike:
http://www.dnepr.ru/index.html

The **eCycle** Hybrid Motorcycle is a 125cc diesel-electric hybrid with a top speed of 80mph, accelerating from 0-60 mph in 6 sec and with fuel consumption at 160 mpg.
http://www.e-cycle.com/powersports/hybrid.htm
See **"Green machines could do 170mph"** -- Motor Cycle News, 12 May 2001
http://www.motorcyclenews.com/news/detail?

sectionID=67356&documentID=59733

Diesel Harley -- Harold Benich's Harley-Davidson Fat Boy diesel runs on soybean oil.
http://www.americanprofile.com/issues/20010930/20010930ne_1354.asp

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Oil yields and characteristics

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Vegetable oil yields

Biodiesel yield = oil yield x 0.8 approx.

Note: These are conservative estimates -- crop yields can vary widely.

Ascending order

Crop	kg oil/ha	litres oil/ha	lbs oil/acre	US gal/acre
corn (maize)	145	172	129	18
cashew nut	148	176	132	19
oats	183	217	163	23
lupine	195	232	175	25
kenaf	230	273	205	29
calendula	256	305	229	33
cotton	273	325	244	35
hemp	305	363	272	39
soybean	375	446	335	48
coffee	386	459	345	49
linseed (flax)	402	478	359	51
hazelnuts	405	482	362	51
euphorbia	440	524	393	56
pumpkin seed	449	534	401	57

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coriander	450	536	402	57
mustard seed	481	572	430	61
camelina	490	583	438	62
sesame	585	696	522	74
safflower	655	779	585	83
rice	696	828	622	88
tung oil tree	790	940	705	100
sunflowers	800	952	714	102
cocoa (cacao)	863	1026	771	110
peanuts	890	1059	795	113
opium poppy	978	1163	873	124
rapeseed	1000	1190	893	127
olives	1019	1212	910	129
castor beans	1188	1413	1061	151
pecan nuts	1505	1791	1344	191
jojoba	1528	1818	1365	194
jatropha	1590	1892	1420	202
macadamia nuts	1887	2246	1685	240
brazil nuts	2010	2392	1795	255
avocado	2217	2638	1980	282
coconut	2260	2689	2018	287
oil palm	5000	5950	4465	635

Alphabetical order

avocado	2217	2638	1980	282
brazil nuts	2010	2392	1795	255
calendula	256	305	229	33
camelina	490	583	438	62
cashew nut	148	176	132	19
castor beans	1188	1413	1061	151
cocoa (cacao)	863	1026	771	110
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Ichijima
Japan

jojoba	1528	1818	1365	194
kenaf	230	273	205	29
linseed (flax)	402	478	359	51
lupine	195	232	175	25
macadamia nuts	1887	2246	1685	240
mustard seed	481	572	430	61
oats	183	217	163	23
oil palm	5000	5950	4465	635
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safflower	655	779	585	83
sesame	585	696	522	74
soybean	375	446	335	48
sunflowers	800	952	714	102
tung oil tree	790	940	705	100

Other oil crops

NewCrop SearchEngine at the Center for New Crops & Plant Products at Purdue University -- Search for "oil". Results: "The following pages containing 'oil' were found -- hits 1-20 of 200". Results are hyperlinked to detailed factsheets.
http://www.hort.purdue.edu/newcrop/SearchEngine.html

Plants For A Future -- Database Search -- See "Search by Use - Select any of the following uses. Or select none and use the plant criteria below." Select "Other Use" - oil. Results: "Other Use: Oil (460)". Results are hyperlinked to detailed factsheets.
http://www.ibiblio.org/pfaf/D_search.html

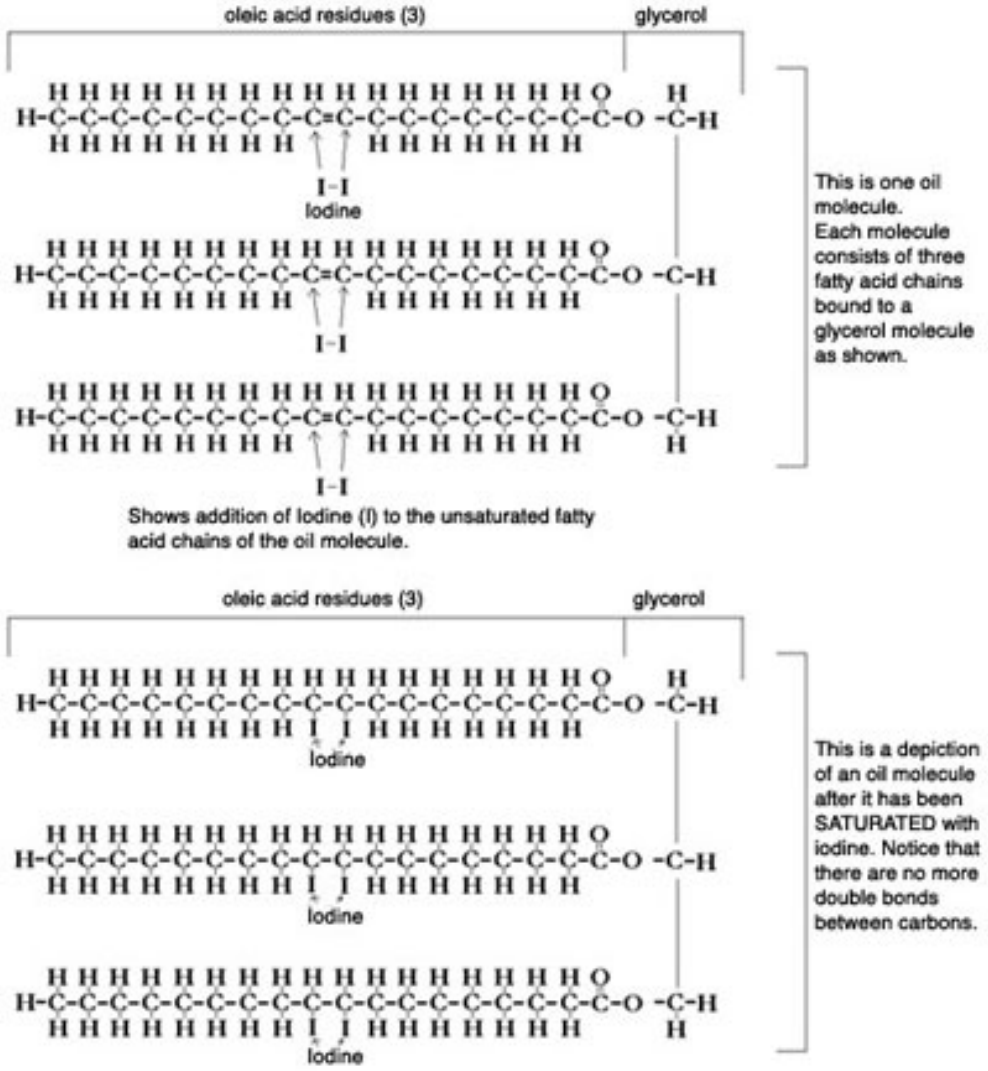
Oils and esters characteristics

Oils and esters characteristics			
Type of Oil	**Melting Range deg C**	**Iodine number**	**Cetane number**

	Oil / Fat	Methyl Ester	Ethyl Ester		
Rapeseed oil, h. eruc.	5	0	-2	97 to 105	55
Rapeseed oil, i. eruc.	-5	-10	-12	110 to 115	58
Sunflower oil	-18	-12	-14	125 to 135	52
Olive oil	-12	-6	-8	77 to 94	60
Soybean oil	-12	-10	-12	125 to 140	53
Cotton seed oil	0	-5	-8	100 to 115	55
Corn oil	-5	-10	-12	115 to 124	53
Coconut oil	20 to 24	-9	-6	8 to 10	70
Palm kernel oil	20 to 26	-8	-8	12 to 18	70
Palm oil	30 to 38	14	10	44 to 58	65
Palm oleine	20 to 25	5	3	85 to 95	65
Palm stearine	35 to 40	21	18	20 to 45	85
Tallow	35 to 40	16	12	50 to 60	75
Lard	32 to 36	14	10	60 to 70	65

Liberty Vegetable Oil Company lists the fatty acid composition of their oils as well as other details such as the Iodine Value, SG, Flash point etc -- Sweet Almond Oil, Pecan Oil, English Walnut Oil, Hazelnut Oil, Macadamia Nut Oil, Soybean Oil, Oleic Sunflower Oil, Canola Oil, Peanut Oil, Sunflower Oil, Corn Oil, Safflower Oil, Soybean Oil (Non-GMO), High Oleic Oils including Canola and Safflower. http://www.libertyvegetableoil.com/products.html

Iodine Values



Chemically, vegetable and animal oils and fats are triglycerides, glycerol bound to three fatty acids. Animal tallow/lard is saturated, meaning that in the fatty acid portion, all the carbon atoms are bound to two hydrogen atoms, and there are no double bonds. This allows the chains of fatty acids to be straighter and more pliable so they harden at lower temperatures (that's why lard is a solid).

As you increase the number of double bonds in a fatty acid, you reduce that ability for oils to gain a conformation that would make them solid, so they remain liquid. To picture it, imagine that you put a bunch of strings in a line. Now tie knots in various places on the strings and see how they don't fit together tightly.

To test a vegetable oil to see how many double bonds it has (how unsaturated it is) iodine is introduced to the oil. The iodine will attach itself over a double bond to make a single bond where an iodine atom is now attached to each carbon atom in that double bond. Higher iodine numbers do not refer to the amount of iodine in the oil, but rather the amount of iodine needed to "saturate" the oil, or break all the double bonds. Oils for the most part contain only trace amounts of iodine naturally.

How does this translate to biodiesel? When the fatty acid chains are broken from the glycerol and then re-esterified to methyl or ethyl groups, those fatty acids still have their double bonds. That means that the more double bonds, the lower the cloud point because they resist solidifying at lower temperatures. So, for instance, if you use lard or tallow, the biodiesel will solidify at a higher temperature because the fat it was formed from also solidified at a higher temperature.

(Image and text compliments of Jeff Welter)

High Iodine Values

[The information below refers to straight vegetable oil fuel, but is also useful to show which oils are suitable for making biodiesel and which may not be suitable.]

-- From "**Waste Vegetable Oil as a Diesel Replacement Fuel**" by Phillip Calais, Environmental Science, Murdoch University, Perth, Australia, and A.R. (Tony) Clark, Western Australian Renewable Fuels Association Inc.
http://www.shortcircuit.com.au/warfa/paper/paper.htm

Many vegetable oils and some animal oils are 'drying' or 'semi-drying' and it is this which makes many oils such as linseed, tung and some fish oils suitable as the base of paints and other coatings. But it is also this property that further restricts their use as fuels.

Drying results from the double bonds (and sometimes triple bonds) in the unsaturated oil molecules being broken by atmospheric oxygen and being converted to peroxides. Cross-linking at this site can then occur and the oil irreversibly polymerises into a plastic-like solid.

In the high temperatures commonly found in internal combustion engines, the process is accelerated and the engine can quickly become gummed-up with the polymerised oil. With some oils, engine failure can occur in as little as 20 hours.

The traditional measure of the degree of bonds available for this process is given by the 'Iodine Value' (IV) and can be determined by adding iodine to the fat or oil. The amount of iodine in grams absorbed per 100 ml of oil is then the IV. The higher the IV, the more unsaturated (the greater the number of double bonds) the oil and the higher is the potential for the oil to polymerise.

While some oils have a low IV and are suitable for use as fuel without any further processing other than extraction and filtering, the majority of vegetable and animal oils have an IV which may cause problems if used as a neat fuel. Generally speaking, an IV of less than about 25 is required if the neat oil is to be used for long term applications in

unmodified diesel engines and this limits the types of oil that can be used as fuel. The table below lists various oils and some of their properties.

The IV can be easily reduced by hydrogenation of the oil (reacting the oil with hydrogen), the hydrogen breaking the double bond and converting the fat or oil into a more saturated oil which reduces the tendency of the oil to polymerise. However this process also increases the melting point of the oil and turns the oil into margarine.

As can be seen from the table below, only coconut oil has an IV low enough to be used without any potential problems in an unmodified diesel engine. However, with a melting point of 25 deg C, the use of coconut oil in cooler areas would obviously lead to problems. With IVs of 25-50, the effects on engine life are also generally unaffected if a slightly more active maintenance schedule is maintained such as more frequent lubricating oil changes and exhaust system decoking. Triglycerides in the range of IV 50-100 may result in decreased engine life, and in particular to decreased fuel pump and injector life. However these must be balanced against greatly decreased fuel costs (if using cheap, surplus oil) and it may be found that even with increased maintenance costs this is economically viable.

Oils and their melting points and Iodine Values

Oil	Approx. melting point deg C	Iodine Value
Coconut oil	25	10
Palm kernel oil	24	37
Mutton tallow	42	40
Beef tallow	-	50
Palm oil	35	54
Olive oil	-6	81
Castor oil	-18	85
Peanut oil	3	93
Rapeseed oil	-10	98
Cotton seed oil	-1	105
Sunflower oil	-17	125
Soybean oil	-16	130
Tung oil	-2.5	168
Linseed oil	-24	178
Sardine oil	-	185

From "Waste Vegetable Oil as a Diesel Replacement Fuel" by Phillip

Calais, Environmental Science, Murdoch University, Perth, Australia, and A.R. (Tony) Clark, Western Australian Renewable Fuels Association Inc.
http://www.shortcircuit.com.au/warfa/paper/paper.htm

Note: More Iodine Values in charts below.

Talking about the weather

Generally, the higher an oil's Iodine Value, the lower the temperature at which it solidifies. Different terms are used for this -- melting point (MP), cloud point (CP), cold filter plugging point (CFPP), and pour point (PP). In practice they all mean about the same. It matters with both SVO systems using straight vegetable oil as fuel and to biodiesel, but more so to SVO systems.

As vegetable oils cool, wax crystals form, and the oil goes cloudy. The crystals can form a film on filters, blocking the flow of fuel. The temperature at which this occurs varies widely according to the oil type, from well below freezing point to well above freezing point.

It even varies for the same type of oil: new food-grade rapeseed or canola oil is usually "winterized" so that it doesn't cloud in the fridge and put people off. It will work nicely down to -10ºC, but once it emerges from the fryer, partly hydrogenated, degraded and probably containing some tallow from the food fried in it, it will only stay liquid and not plug filters down to freezing point or just above.

If you want to use an SVO system in a cold climate, you need a system configured to deal with the CFPP factor, and you need oil with a low CFPP. Coconut oil, palm oil, tallow and lard won't do, rapeseed or canola, soy, sunflower or corn oil are much better.

But if you live in a hot climate, cloud points won't bother you and the opposite is true: coconut and palm oil, tallow and lard all have higher cetane numbers than the others, and lower Iodine Values.

For biodiesel, the same applies, but to a lesser degree -- with most oils and fats, converting it into biodiesel tends to lower the CFPP. Biodiesel made with ethanol usually has a lower CFPP than biodiesel made with methanol. Additives and fuel-line heaters can solve the problem, and so can adding a proportion of petro-diesel or kerosene (up to 30% is usually recommended).

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Quality standard for rapeseed oil fuel

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Fixed oils

From **"The Household Cyclopedia"** (1881)
http://www.publicbookshelf.com/public_html/The_Household_Cyclopedia_of_General_Information/informatio_bjf.html

To make Oil of Sweet Almonds

It is usually made from bitter almonds for cheapness, or from old Jordan almonds, by heat, the oil from which soon grows rank, while that from fresh Barbary almonds, drawn cold, will keep good for some time. The almonds are sometimes blanched by dipping in boiling water, or by soaking some hours in cold water, so as to part with their skin easily, but are more usually ground to a paste, which is put into canvas bags, and pressed between iron plates in a screw press, or by means of a wedge, 1 cwt. of bitter almonds, unblanched, produces 46 lbs. of oil; the cake pays for pressing.

Nut Oil

Is obtained from the kernel of the hazelnut, and is very fine. As it will keep better than that of almonds, it has been proposed to be substituted for that oil. It is drunk with tea in China, probably in lieu of cream, and is used by painters, as a superior vehicle for their colors.

Oil of Mace

Is obtained from nutmegs by the press. It is buttery, having the smell and color of mace, but grows paler and harder by age; 2 lbs. of nutmegs in Europe will yield 6 oz. of this oil.

True Oil of Mace by Expression

This oil is red, remains always liquid or soft, has a strong smell of mace, subacid taste, and is imported in jars or bottles, the lower part being rather thicker than the top; 1 1/2 lbs. of mace will yield in Europe 1 1/2 oz. troy of oil.

Olive, Salad, or Sweet Oil

This is the most agreeable of all the oils; it is demulcent, emollient, gently laxative, and is also used as an emetic with warm water; dose, 1 oz. troy, or a large spoonful; also externally,

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when warm, to the bites of serpents, and, when cold, to tumors and dropsies. Rank oil is best for plasters, but fresh oil makes the best hard soap.

Castor Oil

Is made by pressing the beans, cold or slightly warmed. It may be rendered colorless and odorless by filtering through animal charcoal and magnesia. It is soluble in strong alcohol, and is used as the basis of many hairoils. (See PERFUMERY.)

Oil of Croton

This oil is extracted from Molucca grains, or purging nuts. In its chemical qualities it agrees with castor oil, but is considerably more active, as a single drop, when the oil is genuine, is a powerful cathartic.

Rape Oil

This is made from rape-seed. It dries slowly and makes but a softish soap, fit for ointments. The mucilage it contains may be got rid of, in a great measure, by adding 1/2 ounce of oil of vitriol to 2 pts. of the oil.

To Purify Rape Oil

The following is a simple method of rendering rape oil equal to spermaceti oil, for the purposes of illumination:

Begin by washing the oil with spring-water; which is effected by agitating the oil violently with a sixth part of the water. This separates the particles of the oil, and mixes those of the water intimately with them. After this operation it looks like the yolk of eggs beat up. In less than 48 hours they separate completely, the oil swimming at the top, the water, with all feculent and extraneous particles, subsiding to the bottom. This may be very much improved, by substituting sea water in the place of fresh-water.

By the process of washing the oil does not lose a hundredth part. The experiment can at all times be made in a glass decanter, or in a churn, with a cock at the bottom, the water to come up very near to the cock, by which all the oil can be drawn off, after it has deposited its impurities.

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To 100 parts of oil add 1 1/2 or 2 of concentrated sulphuric acid, and mix the whole well by agitation; when the oil will become turbid, and of a blackish-green color. In about three-quarters of an hour the coloring matter will begin to collect in clots; the agitation should then be discontinued, and clean water, twice the weight of the sulphuric acid, be added. To mix the water with the oil and acid, a further agitation of half an hour will be requisite. The mass may, afterwards, be left to clarify for 8 days, at the end of which time 3 separate fluids will be perceived in the vessel; the upper is the clear oil, the next is the sulphuric acid and water, and the lowest a black mud or fecula. Let the oil then be separated by a syphon from the acid and water, and filtrated through cotton or wool. It will be nearly without color, smell, or taste, and will burn clearly and quietly to the last drop.

To Purify Vegetable Oil

To 100 lbs. of oil add 25 oz. of alum, and mix, dissolved in 9 lbs. of boiling water. After stirring it about half an hour, add 15 oz. of nitric acid, still continuing to stir it. Let it stand 48 hours, when the fine oil will swim on the surface, and then draw it off. Such oil is used all over the Continent, and an equal quantity yields double the light of whale and fish-oil without its offensive odor.

To make Pumpkin Oil

From the seeds of the pumpkin, which are generally thrown away, an abundance of an excellent oil may be extracted. When peeled they yield much more oil than an equal quantity of flax. This oil burns well, gives a lively light, lasts longer than other oils, and emits very little smoke. It has been used on the Continent for frying fish, etc. The cake remaining after the extraction of the oil may be given to cattle, who eat it with avidity.

Beech Nut Oil

Beech-nuts are not only an excellent food for pigs, but they are known to yield an oil, fit for common purposes, by the usual methods of extraction.

ANIMAL OILS AND FATS

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Hog's Lard

This is obtained like the rest of the animal fats, from the raw lard, by chopping it fine, or rather rolling it out, to break the cells in which the fat is lodged, and then melting the fat in a waterbath, or other gentle heat, and straining it while warm. Some boil them in water, but the fats thus obtained are apt to grow rank much sooner than when melted by themselves.

Neat's-foot or Trotter Oil

Obtained by boiling neat's-feet, tripe, etc. in water. It is a coarse animal oil, very emollient, and much used to soften leather.

To Purify Trotter Oil

Put 1 qt. of trotter oil into a vessel containing 1 qt. of rose-water, and set them over a fire till the oil melts and mixes with the rose-water. Stir well with a spoon. When properly combined take the vessel from the fire, and let it cool. Now take off the oil with a spoon, and add rosewater as before. When the oil is again separated and cleansed, set it in a cool place. The principal use of trotter oil is for the making of cold cream, in which its qualities exceed those of every other oil.

To Prepare Oil from Yolks of Eggs.

Boil the eggs hard, and after separating the whites break the yolks into 2 or 3 pieces, and roast them in a frying pan till the oil begins to exude, then press these with very great forge. Fifty eggs yield about 5 oz. of oil. Old eggs yield the greatest quantity.

Another Method.

Dilute the raw yolks with a large proportion of water, and add spirit of wine to separate the albumen, when the oil will rise on the top after standing some time, and thus may be separated by a funnel.

To Refine Spermaceti.

Spermaceti is usually brought home in casks, and in some cases has so little oil mixed with it as to obtain the denomination of head matter. It is of the consistence of a stiff ointment, of a yellowish color, and not tenacious. Besides the head matter, there is also a quantity of sperm obtained from the oil by

filtration. Indeed, in all good spermaceti lamp oil, which is not transparent, particles of the sperm may be seen floating.

Having the head-matter, or filtered sperm, in order to purify it, first put it into hair-cloths, and with an iron plate between each cloth to the number of half a dozen or more, submit it to the action of an iron screw-press, and, as the oil does not separate very readily, it will in general be necessary to let the cakes of sperm be pressed three different times. The third time the cakes will become so dry that they may be broken in small pieces with little trouble, and then put in a furnace containing 1/3 water and 2/3 cake. Let the fire be raised sufficiently under the furnace to melt the cake, which it will do before the water begins to boil; after which boil the whole together for about 1/2 an hour, taking off during the boiling what scum and other extraneous bodies rise to the top, then let the whole be dipped out into a tub or other coolers. After it is completely cold take off the cake of spermaceti, which will be on the top of the water, and cut it into pieces. Suppose, for example, that the cake weighs 1 cwt., it will be necessary to have a furnace, or rather a movable kettle, where the light is thrown in such a way that the process can be observed. Having taken 1 cwt. of the unrefined spermaceti prepared as above, melt it together with about 3 galls. of water. As soon as it begins to boil add from time to time small portions of the following liquor, say 1/2 pint at a time: Take of the alkaline salt, or potash, 7 lbs.; pour on it 2 galls. of water; let them stand together 24 hours, and from the top dip off the lye as wanted, adding more water occasionally, till the alkali is exhausted. After boiling the spermaceti for about 4 hours, having during the process taken off the scum as it arose, let the kettle be removed from the fire; and after remaining about 1/4 hour, dip off the spermaceti into suitable coolers. This process must in general be repeated 3 times. The third time, if the processes have been properly conducted, the spermaceti will be as clear as crystal; and then, after it is cool, the only thing necessary to make it fit for sale, is to cut it into moderately small pieces, when it will break into that flakey appearance which it has in the shops.

To Sweeten, Purify, and Refine Greenland Whale and Seal Oil.

The oil, in its raw state, is filtered through bags about 41 inches long, with circular mouths extended by a wooden hoop about 15 inches in diameter, fixed thereto. These bags are made of jean lined with flannel, between which jean and powdered charcoal is

placed, throughout, to a regular thickness of about 1/2 inch, for the purpose of retaining the glutinous particles of the oil and straining it from impurities; and the bags are quilted, to prevent the charcoal from becoming thicker in one part than another, and to keep the linings more compact. The oil is pumped into a large funnel made of tin, annexed to the pump through a perpendicular pipe, and passed from the funnel into another pipe placed over the bags horizontally, from whence it is introduced into them by cocks. The oil runs from the filteringbags into a cistern about 8 feet long by 4 feet broad, and 4 1/2 deep, made of wood and lined with lead and containing water at the bottom about the depth of 5 or 6 inches, in which are dissolved about 6 oz. of blue vitriol, for the purpose of drawing down the glutinous and offensive particles of the oil which have escaped through the charcoal; and thereby rendering it clean and free from the unpleasant smell attendant upon the oil in the raw state; and in order to enable the oil thus to run from the bags, they are hung in a frame or rack made like a ladder, with the spokes or rails at sufficient distances to receive the hoop of the bag between two; and such frame or rack is placed in a horizontal position over the cistern. The oil is suffered to run into the cistern until it stands to the depth of about 2 feet in the water, and there to remain for 3 or 4 days, (according to the quality of the oil), and is then drawn off by a cock which is fixed in the cistern a little above the water, into a tub or other vessel, when it will be found to be considerably purified and refined; and the oil after having undergone this operation, may be rendered still more pure by passing a second or third time through similar bags and cisterns. But the oil after such second and third process, is drawn off into and filtered through additional bags made of jean lined with flannel, inclosed in other bags made of jean, doubled, when the process is complete.

Clarifying Coal-Oils

In a close vessel are placed 100 lbs. of crude coaloil, 25 qts. of water, 1 lb. of chloride of lime, 1 lb. of soda, and 1/2 lb. of oxide of manganese. The mixture is violently agitated, and allowed to rest for 24 hours, when the clear oil is decanted and distilled. The 100 lbs. of coaloil are to be mixed with 25 lbs. of resin-oil; this is one of the principal points in the manipulation; it removes the gummy parts from the oil, and renders them inodorous. The distillation spoken of may terminate the process, or the oils may be distilled before they are defecated and precipitated.

To Bleach and Purify Fixed Oils

Fish and other fat oils are improved in smell and color by passing hot air or steam through them. Dunn's method is to heat the oil by steam to 170° or 200°, and force a current of air through it, under a chimney, till it is bleached and purified. Mr. Cameron's method of bleaching palm oil is to keep it at 230°, with continual agitation, by passing into it high pressure steam through leaden pipes of 2 inches diameter. Four tons of oil require 10 hours' straining. Palm oil is also bleached by chloride of lime. Take from 7 to 14 lbs. of chloride of lime, triturate in a mortar, adding gradually 12 times the quantity of water, so as to form a smooth cream. Liquefy 112 lbs. of palm oil, remove it from the fire, add the solution of chloride of lime, and stir well with a wooden stirrer. Allow it to cool, and when become solid break it into small fragments, and expose it to the air for 2 or 3 weeks, then put into a cast-iron boiler lined with lead, diluted with 20 parts of water. Boil with a moderate heat till the oil drops clear from the stirrer; then let it cool. To remove the foetor from fish oils, treat them in the same way (except the exposing to the air), using only 1 lb. of chloride of lime to 112 lbs. of oil, It does not remove the natural smell of the oil.

Calcined magnesia has been used to deprive oils of their rancidity.

Mr. Griseler finds that the addition of a few drops of nitric ether will prevent oils from becoming rancid.

Mr. Watt's patented method of bleaching oil is by chromic acid. For palm oil it is thus used: The oil is heated in a steam vessel, allowed to settle and cool down to 130° Fahr., then removed into wooden vessels, taking care that no water or sediment accompany it. For a ton of palm oil make a saturated solution of 25 lbs. of bichromate of potash; add 8 lbs. of sulphuric acid, and 60 lbs. of muriatic acid (or an equivalent quantity of salt and sulphuric acid). Put the mixture into the oil, and let it be constantly stirred till it becomes of a light-green color. If not sufficiently decolored, add more of the mixture. Let the oil settle for half an hour, then pump it into a wooden vat, boil it for a few minutes with fresh water, by means of a steam pipe, and let it settle. For linseed, rape and mustard oils a dilute solution of chromic acid is used, with a little muriatic acid; for olive, almond, and castor oils no muriatic acid is required. Fish oils and fats are first boiled in a steamapparatus with a weak soda lye (1/2 lb. of soda for every ton of fat) for half an hour; then 1/2 lb.

Of sulphuric acid, diluted with 3 lbs. of water, is added, the whole boiled for 16 minutes, and allowed to settle for an hour or more, when the water and sediment are drawn off, and the oil further bleached by a solution of 4 lbs. of bichromate of potash and 2 lbs. of sulphuric acid, properly diluted.

Mr. Davidson treats whale oil first with a solution of tan, next with water and chloride of lime, and lastly with diluted sulphuric acid and warm water. Rape and other seed oils are also refined by means of sulphuric acid and twice as much water. Mr. Gray directs 2 lbs. of oil of vitriol to 112 lbs. of oil. The oil should be carefully washed from the acid and filtered.

Mr. Bancroft's process for refining common olive oil, lard oil, etc., for lubricating purposes, is to agitate them with from 3 1/2 to 8 per cent. of caustic soda lye, of 12 specific gravity. If, on trial of a small quantity, the lye he found to settle clear at the bottom, enough has been added. The oil is allowed to rest for twenty-four hours for the soapy matter to subside: the supernatant oil is then filtered.

Another plan of purifying oils (especially lamp oils) is to agitate them with a strong solution of common salt.

Purification of Castor Oil

Mix 1000 parts of the oil with 25 parts of animal charcoal, and 10 parts of calcined magnesia, and leave them together for 3 days at a temperature of 68° to 78° Fahr., often stirring or shaking the mixture. The oil is then filtered off, and is found to be limpid, colorless, without taste, and easily soluble in alcohol. It congeals, too, at a lower temperature than before, and is in that respect superior to the ordinary oil.

Oil of Brick

Used by lapidaries, is made by saturating fragments of brick with oil and distilling at a red heat.

Watchmaker's Oil

1. Expose the finest porpoise oil to the lowest natural temperature attainable. It will separate into two portions, a thick, solid mass at the bottom, and a thin, oily supernatant liquid. This is to be poured off while at the low temperature named, and is then fit for use.

2. Put into a matrass or glass flask, a portion of any fine oil, with 7 or 8 times its weight of alcohol, and heat the mixture almost to boiling; decant the clear upper stratum of fluid, and suffer it to cool; a solid portion of fatty matter separates, which is to be removed, and then the alcoholic solution evaporated in a retort or basin, until reduced to one-fifth of its bulk. The fluid part of the oil will be deposited. It should be colorless and tasteless, almost free from smell, without action on infusion of litmus, having the consistence of white olive oil, and not easily congealable.

3. Take a white glass bottle of pure olive or almond oil, put into it a coiled strip of lead, and expose it to the sun's rays until a white curdy matter ceases to be deposited.

To Prevent Fats and Oils from becoming Rancid

Heat the oil or melted fat for a few minutes with powdered slippery-elm bark, in the proportion of 1 dr. of the powder to 1 lb. of fat. The bark shrinks and gradually subsides, after which the fat is poured off. It communicates an odor like that of the hickory-nut. Butter thus treated has been kept unchanged for a year.

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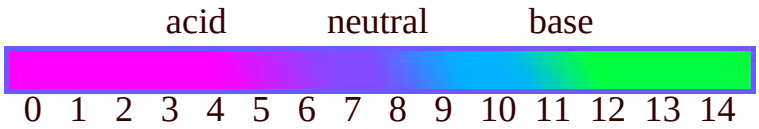
Test papers

From **"The Household Cyclopedia"** (1881):
http://www.publicbookshelf.com/public_html/The_Household_Cyclopedia_of_General_Information/phtestpa_bjd.html

Distilled water only should be used in these preparations. In preparing the papers the liquid should be placed in an earthenware plate or dish, and the paper carefully immersed in it so as to be uniformly wetted then dried out of the reach of acid, ammoniacal, or other vapors likely to affect it; and afterwards kept in bottles, jars, or cases.

Cabbage Paper

Make a strong infusion of red cabbage leaves, strain it, and evaporate it by a gentle heat till considerably reduced. Then dip the paper in it and dry it in the air. [This paper is of a grayish color; alkalies change it to green, acids to red. It is a very delicate test; if rendered slightly green by an alkali, carbonic acid will restore the color.]



From Miami Museum of Science
http://www.miamisci.org/ph/hexplore1.html

pH test strips from Red Cabbage
http://www.plantsfood.com/ph.htm

Brazil Paper

Dip paper in a strong decoction of Brazil wood and dry it. [It is rendered purple or violet by alkalies; generally yellow by acids.]

Dahlia Paper

From the petals of violet-dahlias, as cabbage paper.

Elderberry Paper

This is merely paper stained with the juice of the berries. Its blue color is changed to red by acids, and to green by alkalies.

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Indigo Paper

Immerse paper in sulphate of indigo, wash it with water rendered slightly alkaline, then with pure water, and dry it in the air.

Iodide of Potassium and Starch Paper

Mix starch paste with solution of iodide of potassium, and moisten bibulous paper with it. [It becomes blue when exposed to ozone. Chlorine has the same effect.]

Lead Paper

Paper dipped in a solution of acetate of lead. [When moistened it detects sulphuretted hydrogen, which renders it black.

Blue Litmus Paper

Bruise 1 oz. of litmus in a mortar, and add boiling water; triturate together, put them in a flask and add boiling water to make up to half a pint; when cool strain it, and dip paper in it. More color may be extracted from the litmus by hot water, but the liquid will require to be concentrated by evaporation. [Acids change the color to red, but it does not become green with alkalies.]

Red Litmus Paper

As the last, adding to the strained infusion few drops of nitric acid, or of pure acetic acid.

Rose Paper

Make a strong infusion of the petals of the red rose, and dip unsized paper in it. [Dipped in an alkaline solution so weak as not to affect turmeric paper, it assumes a bright green color.]

Manganese Paper

Dip paper in a solution of sulphate of manganese. [It becomes black in an ozonized atmosphere.]

Rhubarb Paper

Dip paper in a strong infusion of rhubarb, and dry it. [Alkalies render it brown. It is not, like turmeric paper, affected by boracic

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acid.]

Starch Paper

This is merely paper imbued with starch paste. Cotton cord is sometimes used instead of paper. [As a test for iodine, which turns it blue.]

Turmeric Paper

Boil 1 oz. of coarsely powdered turmeric-root in 1/2 a pint of water for 1/2 an hour, and strain; dip paper in the liquid and dry it. [It is rendered brown by alkalies, and also by boracic acid and borates.]

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Making lye from wood ash

Lye made from wood ash is potassium hydroxide, not sodium hydroxide -- there's 10 times as much potassium as sodium in wood ash.

The process makes lye water. If you boiled off all the water you could use it as the catalyst to make biodiesel, but you'd need more accurate pH measures than those listed below. The usual pH meter or litmus papers would do. See also Natural test papers.

If you try this, we'd be very interested to know the results -- please contact us.

Making the lye

Drill a lot of holes in the bottom of a small wooden barrel, make sure it's waterproof before you drill the holes!

Stand the barrel on blocks leaving space beneath the barrel for a container. Use a waterproof wood or glass container. Lye can burn through some metals.

Put a layer of gravel in the bottom of the barrel over the holes, then put a layer of straw over the gravel. Fill the rest of the barrel with hardwood ash (NOTE: hardwood -- NOT softwood), leaving a couple of inches at the top clear. Then pour rainwater into the barrel. After a long time the water in the barrel will start to drip into the container. Leave it until it stops, then replace the container with another in case of odd drips.

Use an old iron pot, or a steel pan (One you will not be using for anything else!). Boil the liquid until it is so concentrated that a fresh egg (still in it's shell please!) will float on top. Then destroy the egg. Remember to take all precautions not the let the liquid touch your skin or clothing.

To test the strength of the lye you need a saturated solution of salt. Dissolve chemical-free salt in a pint of water until no more salt will dissolve. Take a stick and put a small weight on the end of it and float it in a pint of the salty water. The weight will sink to the bottom, while the top of the stick will float. Make a mark on the stick where it reaches the water line. Then float the stick

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and weight in a pint of lye. The mark on the stick will probably be above the water mark of the lye. If so, stir in some more rainwater until the mark on the stick is in exactly the same place it was in the salt water. You now have the correct distillation of lye for making soap.

From "How to Make: SOAP"
http://www.oldcity.demon.co.uk/shez/m_make.html#make2

Making "Lye Water"

Soap making uses a caustic solution known as "Lye Water".

When available, Caustic Soda is used. Here we will make Lye Water out of certain wood ashes and "soft water".

1) White Ashes

Dried palm branches, dried out banana peels, cocoa pods, kapok tree wood, oak wood, (or for really white soap, apple tree wood) make the best lye ashes. Ordinary wood used in cooking fires will do.

Whatever wood is used, it should be burned in a very hot fire to make very white ashes.

When cold, these are stored in a covered plastic bucket or wooden barrel, or stainless steel container. If these are not available, a clay pot-jar which has been fired in a pottery making kiln (not just dried in the sun).

A wooden drum or barrel which has a tap at the right is best.

2) Soft Water

Water from a spring or from showers of rain is called "soft water", because it does not have metallic or acidic chemicals in it.

This makes it useful for soap making, as there are no other chemicals in it which would get in the way of making soap.

"Ordinary" bore, well, or river water can be used for making soap, but this will sometimes need to have a "washing soda" or "baking soda" added to it. Otherwise some of the chemicals in the water will get in the way of making the soap.

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If you are using "ordinary" water and you want to test it to see if some soda needs to be added, simply try to make soap bubble up (foam) in it.

If the soap easily foams up, the water is probably ok as it is.

If not, try adding a little bit of soda at a time stirring it to make it disappear, until the water will foam the soap up.

Then add the same amount of soda to the same amounts of the water that you wish to use to make the soap. For example, if you were testing a 1/4 (a quarter) of a bucket of water, and you ended up needing 1/8 (an eighth) of a cup of soda, then you would need 4/8 (or 1/2-half) a cup of soda for a full bucket of "ordinary" water.

However you have got it, store the "soft water" in covered wooden, plastic, or stainless steel buckets or containers. (Again, a clay-jar as described above can be used if needed.)

"Safe" Containers

Any of the types of containers, buckets, barrels or jars described in the White Ashes or Soft Water sections are called "safe containers".

Making "Lye Water"

If you are going to use a large barrel or drum to make the lye water in, and it has a tap or hole at the right, place some kind of filter on the inside of the barrel around the opening.

Fill the barrel with white ashes to about four inches (10 cm or 0.1 metre) below the top.

Boil half (1/2) a bucket full of soft water (about 10 pints or six litres), and pour over the ashes.

Slowly add more cold soft water until liquid drips out of the barrel. Close the tap or block the hole.

Add more ashes to top the barrel up again, and more soft water. Do not add so much water that the ashes swim.

Leave to stand for four or more hours (or overnight if you have the time). Later pour the brownish lye water into a plastic or

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other "safe" container(s). Then pour back through the ashes again. Let the lye water drip into "safe" containers.

When the brown lye water stops coming out of the barrel, or ash container, then pour four to five pints (2-1/2 to three litre) of soft water through the ashes, collecting the lye which comes out in a separate "safe" container (as this lye may be weaker than the first lot).

Repeat this using two to three pints (one to two litres) of soft water, until no more brown liquid comes out of the ashes.

Either put the lye into "safe" bottles, or cover the "safe" containers which it is in. Dig the ashes into the vegetable garden.

Lye Water Strength

If an egg or potato will float just below halfway, or a chicken feather starts to dissolve in it, then the lye water is at the right strength.

If the egg will not float, then the lye water could be boiled down if you want it to be stronger.

If the egg seems to pop up too far, add a little bit of soft water (a cup at a time) stirring the lye water, until the egg floats so that its head pops up.

From Soap Making - Traditional Methods: Lye Rain Water Wood Ash
http://ourworld.compuserve.com/homepages/paul_norman_3/SOAPMAKE.HTM

Make The Lye

In making soap the first ingredient required was a liquid solution of potash commonly called lye.

LYE LEACHING APPARATUS

The lye solution was obtained by placing wood ashes in a bottomless barrel set on a stone slab with a groove and a lip carved in it. The stone in turn rested on a pile of rocks. To prevent the ashes from getting in the solution a layer of straw and small sticks was placed in the barrel then the ashes were put on top. The lye was produced by slowly pouring water over the ashes until a brownish liquid oozed out the bottom of the barrel. This solution of potash lye was collected by allowing it to flow into the groove around the stone slab and drip down into a clay vessel at the lip of the groove.

ASH HOPPER

Some colonists used an ash hopper for the making of lye instead of the barrel method. The ash hopper, was kept in a shed to protect the ashes from being leached unintentionally by a rain fall. Ashes were added periodically and water was poured over at intervals to insure a continuous supply of lye. The lye dripped into a collecting vessel located beneath the hopper.

The hardest part was in determining if the lye was of the correct strength, as we have said. In order to learn this, the soap maker floated either a potato or an egg in the lye. If the object floated with a specified amount of its surface above the lye solution, the lye was declared fit for soap making. Most of the colonists felt that lye of the correct strength would float a potato or an egg with an area the size of a ninepence (about the size of a modern quarter) above the surface. To make a weak lye stronger, the solution could either be boiled down more or the lye solution could be poured through a new batch of ashes. To make a solution weaker, water was added.

From Colonial Soap Making: Its History and Techniques -- The Soap Factory
http://www.alcasoft.com/soapfact/history.html

"When a fresh egg floats with a nickel-sized to quarter-sized area above the surface, the liquor is ready for soap making." -- Homestead mailing list.
Nickel = 2 cm diameter
Quarter = 2.5 cm diameter

At the turn of the last century lye was obtained by leaching water through wood ashes. At best, the concentration of potassium hydroxide in the resulting lye water was always questionable. My grandmother said that she could tell if the lye water was the right strength by using the wing feather pulled from her favorite goose. She would pour the lye water into a 30 gallon cooking pot and heat the solution. Next she would touch the feather to the heating lye. If the feather dissolved, the lye was strong enough to dissolve pig fat.
-- Soap Making Today

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Bubble washing

Bubble washing takes time, but it saves water and does a better job.

Unless you're in a hurry, leave your biodiesel to settle before washing it, for a week or longer if possible. Settling makes for less alkalinity and an easier wash using less water.

After washing, let it settle again before using it. A deposit can form at the bottom, so always draw your fuel from the top of the container.

There are several variations on the washing theme. Here's Aleks Kac's process with the two-stage acid-base "Foolproof" method: **Washing.**

Mike Pelly's method: **Washing and drying**.

Here's a bubble-washing **How-to** posted to the **Biofuels discussion group** by Terry de Winne in the UK.

Bubblewashing 101 by Maria Alovert -- "Girl Mark Fire" -- also posted to the **Biofuels discussion group**.

Simon's Super Bubbler

The air stone is made from an 8-inch grinding wheel.

The bottom is sealed with the lid from a coffee tin.

The air hoses are fed into the centre hole. Any gaps are sealed with gasket sealer then the whole thing is held together with cable ties.

Washing problems

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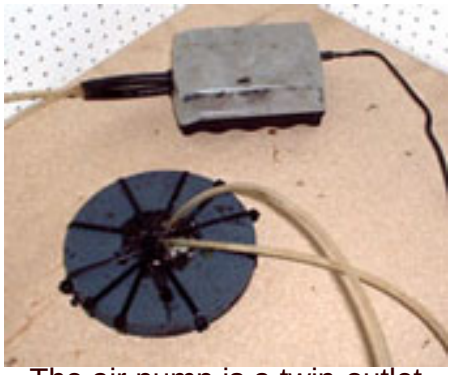
Using acid



The air pump is a twin-outlet fish tank pump designed for a 140-litre fish tank.
-- Simon Wells, Veggiepower: http://www.veggiepower.org.uk

Some people say it's a mistake to "quench" the wash with acid. They say that while the acid will neutralize the alkali catalyst, it will also convert some of the soap to Free Fatty Acids (FFAs), which dissolve back into the biodiesel, and which you don't want in your fuel.

We seldom use acid in the wash, but many people get good results using an acid quench. Some of them have had their biodiesel analysed, again with good results -- acid-quenched biodiesel can and does meet and exceed standard specifications such as DIN 51606 and ONORM.

Bubblewashing: milky water after the first wash...

Does it in fact convert soap to FFAs? Typical quantities of acid used are: 8 milliliters of 5% vinegar per liter of wash water used (usually a quarter to half as much water as the amount of oil used); 2 milliliters of 10% phosphoric acid per liter of washing water; enough ("not much") 5% phosphoric acid to bring the pH down to 7 (neutral) -- this last from Martin Steele, who makes high-quality home-brew biodiesel that passes the analysis test with ease.

2nd wash -- murky water...

This is how to convert soap to FFAs: **Separating glycerine/FFAs**. What it says is that for "average" WVO, titrating at 3 ml, you'd need 9.75 ml of 85% phosphoric acid per liter of oil used to convert the soap to FFAs, thus separating it from the glycerine. That's about 50 times as much acid as you'd use to quench the wash, and in the wash it's buffered by all that water too. FFAs? Naah. But be sparing with the acid anyway.

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3rd wash -- clear water at pH7, clear biodiesel on top

Froth

Beginners sometimes have a lot of trouble with the wash -- as soon as they start the bubbler the mixture starts to froth up and "boils over". This will partly be due to excess soap, but more likely because the biodiesel reaction didn't go far enough, leaving unconverted or partly converted material in the fuel. These will be di-glycerides and mono-glycerides -- the frothing will be caused by the mono-glycerides, which work as emulsifiers.

Frothing can be quenched by using more acid, and it will probably need more washing than usual, but the real solution is to improve the process. Poor titration, insufficient methanol, inadequate agitation, low process temperature, not enough mixing time can all lead to an incomplete process.

Disposal

Used wash-water is about as innocuous as the average family's laundry water, or more innocuous if they have infants in diapers. It's at its most innocuous if you recover the excess methanol for reuse before washing. The water from later washes can be reused for the first washes of the next batch. You can treat used wash-water in a simple greywater system.

Washing myths

Ian uses three of these pneumatic exhaust silencers for bubble washing. They don't rot, they're cheap and they work very well. See: Ian's vacuum biodiesel processor

Some biodieselers don't wash their fuel -- there's no evidence that it does any damage, they say. Yes there is! See **Why quality matters**. Another longstanding myth is that methanol is good fuel, why wash out the excess methanol, what a waste! Methanol is a good fuel in specially prepared race car engines -- gasoline engines. Excess methanol in unwashed biodiesel is not good fuel and does harm, corroding the fuel injection system. Quality biodiesel is washed biodiesel.

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Biodiesel and your vehicle

Compatibility:
-- Filters
-- Timing
-- Rubber
Quality
-- Why quality matters
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-- Standards for biodiesel
Using biodiesel in winter

Very Frequently Asked Question: "Can I use biodiesel in my car?"

Answer: If it's a diesel, yes. But there are a few things you need to know.

Filters

First is that conventional fossil-fuel petrodiesel is dirty stuff -- not only are the exhaust fumes dirty, but the fuel itself leaves a dirty deposit. Biodiesel isn't only clean, it's a good cleaner -- it does a great job of cleaning up the gunge fossil diesel leaves in the tank and fuel system. So when you first switch to biodiesel, check the fuel filters often and change them when needed. The first few weeks are the most critical.

Timing

Retard the injection timing by 2-3 degrees -- this overcomes the effect of biodiesel's higher **cetane** number. The engine loses a little of the extra power you get with biodiesel, but it runs quieter and the fuel burns cooler, reducing NOx emissions. (See also **NOx emissions and biodiesel**.)

Rubber

Any rubber parts in the fuel system may corrode in time with biodiesel, especially 100% biodiesel (B100). Newer cars (since the mid-1990s) do not use rubber parts. Biodiesel has been used in many older motors without any problems. If necessary, check with your vehicle's manufacturer. Viton parts are best. Check this

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table: "**Durability of Various Plastics: Alcohols vs. Gasoline**", see Methanol.

This is what commercial biodiesel producer **Camillo Holecek** of Biodiesel Raffinerie GmbH, Austria (http://www.energea.at/en_info.html) has to say about it:

"As a commercial producer I used to tell my clients: Any European car maker's product after 1996 is 100% biodiesel-proof, as countries like France are already mixing 5% biodiesel in their standard diesel fuel sold at the pump, and in the Czech Republic it is 30% in the 'Bio-Naphta' that is also sold to anyone at the pump, and none of those car makers wants to get a bad name that his brand car failed in those important markets.

"And by the way, Nissan Austria just approved its Primera for 100% biodiesel, too.

"We did hear of a few medium-aged trucks having the original injection pump seals going to pieces, after growing bigger over several months due to biodiesel 'attack'."

Terry de Winne (Biofuels for Sustainable Transport -- http://www.biofuels.fsnet.co.uk/) has this to add:

"Ultra low sulphur diesel fuel (ULSD) suffers from two things -- lack of the lubricity of the sulphur and also its ability to vulcanise any rubber components. Ergo, when Europe went over to ULSD in 1993/95, all fuel components were changed by all manufacturers to Viton or similar plastic.

"Initially, supplies of ULSD were found to be very harsh on the injectors and caused many problems. Most oil companies added lubricity additives to compensate.

"The French, being farmer-friendly, opted for biodiesel. The three main companies add 5% to all their ULSD. Shell International adds just 2%, but even this small amount is enough to compensate for the removal of the sulphur. It also oxygenates the fuel and brings the emission levels down marginally -- particularly carbon monoxide and nitrous oxide.

"Hence, all Euro vehicles are compatible with biodiesel, whether or not the manufacturers acknowledge it.

"Biodiesel, being an organic substance, tends to be absorbed by

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natural rubber -- after a month or so exposure, the rubber swells and rots. This applies to all ratios of biodiesel additive to petrodiesel. A tank or two to try it out will do no harm, if ULSD or standard diesel fuel is used thereafter.

"This is particularly applicable when using biodiesel in diesel generators, which are usually designed to run on high sulphur fuel, so probably have rubber hoses."

American biodieseller and biofuels activist **Maria Alovert (Girl Mark)** of the Berkeley Ecology Center thinks it's less of a problem than it's sometimes made out to be:

"If you're a commercial producer or industry person there's a set of responsibilites about telling people the most conservative thing you can. One of those responsibilities is the liability -- you could get sued if you don't give a customer all the warnings.

"In reality there are not a lot of problems with seals and hoses on most 1980s vehicles available in the US, at least not catastrophic problems, and they do take a long time to happen. People sometimes get some leaks -- usually thousands and thousands of miles into B100 use, the return lines on mid-80s VWs being the most common ones I've seen leak (actually the only ones I've seen leak in anybody's vehicles). I've been hanging around with biodieselers for several years and don't know of any leaks beyond these VW ones (which doesn't stop anyone from using B100 in mid-80s VWs). They're easily fixable when they do go. It's not very common for it to be injector pump parts or anything serious, it's usually visible fuel lines.

"One reason besides liability that we see a lot of emphasis on this 'anything better than B50 will cause leaks' bit, is that the information is coming in part from the NBB (US National Biodiesel Board). The NBB takes the attitude that biodiesel is a fuel extender. They pay lip service to B100 but they're primarily interested in B20, and they stress such blends as much as they can. Of course as the industry organization they have to tell people the most conservative advice they can. They also advise against SVO (Straight Vegetable Oil) and home-made biodiesel -- it's their job. It doesn't mean that we don't prove them wrong every day.

"B100 does damage to various types of rubber, at rates that vary widely. Nitrile is one material that is damaged by B100. But I use it every day in contact with B100 in the form of pumps used in the processing (they sit with B100 in them for 24 hours 7 days a

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week), which contain nitrile parts, I use nitrile hose washers (the black 0-ring kind of garden hose washer is nitrile), nitrile gloves, and other nitrile gasketing material. In my experience though B100 theoretically swells and weakens nitrile, it has not shown any damage over the year that I've been aware of that type of rubber as being nitrile.

"Conditions may be different in a fuel system due to heat, but I imagine that it's somewhat similar with vehicle fuel system components -- petrodiesel is pretty aggressive and attacks some kinds of rubber as well, so 'rubber' parts in fuel systems tend to be made fairly stable and resistant to corrosion. So if it goes at all it isn't immediate and it isn't catastrophic. Obviously not all of them, across the board -- but I think the 'automatically replace all your fuel system stuff with Viton' advice is akin to the 'don't do SVO it's unproven' advice we used to hear."

Quality

Biodiesel made from different kinds of oil can have slightly different characteristics (see **Oils and esters characteristics**) -- some are better for cold climates, for instance, while using ethanol as the alcohol ingredient (**ethyl esters**) gives slightly different results from methanol (methyl esters). But they are all excellent fuels, even when made from used cooking oils -- as long as they're well made. You CAN make high-quality biodiesel yourself if you follow the instructions given on this site.

- **Make your own biodiesel**
- **Mike Pelly's biodiesel recipe**
- **Aleks Kac's two-stage process**
- **Aleks Kac's FOOLPROOF biodiesel method**

Jack Kenworthy of the Cape Eleuthera Island School in the Bahamas joined our **Biofuel mailing list** in November 2002 as a novice. List members helped him learn how to make biodiesel from scratch, helped him solve problems he encountered, then helped him design and build a processor. Nine months after joining he wrote to the list:

"Hey All -- just thought I would let you know that I just received my results from the ASTM tests [the US ASTM D-6751 biodiesel standard] and we passed all categories. Just another good example of a homebrewer in a remote setting (Bahamas) making spec-grade biofuel! Thanks! -- Jack"

Jack uses the single-stage base process and makes the fuel in 150-gallon batches, totalling about 300 gallons a week. He uses waste vegetable oil from cruise liners that call at the island once a week.

Standards and the homebrewer: "Most of the standards can be met simply by preparing and washing the fuel well," says **Todd Swearingen** of **Appal Energy**.

Aleks Kac, making homebrew biodiesel with his "Foolproof" acid-base two-stage process, has passed the German DIN 51606 tests twice, as well as the Austrian ONORM test, with samples taken from his normal production without any special preparation.

A message from **Martin Steele**, ace biodieseler from Manchester, UK -- Martin took the injectors out of his 1989 Volvo 940 (VW 2.5 IDI engine) to do an inspection and No 2 snapped off in the block. It was stuck when he bought the car. The problem was corrosion between the injector body and the cylinder head -- not fuel-related. He decided to take the car in to a professional engineer and give it a thorough inspection after 30,000 miles on his home-made biodiesel.

"What a day, we finally cracked the cylinder head open, I waited with baited breath, what was about to be revealed was beyond my best hopes: all five pots (No 2 injector was stuck when I bought the car, 1-3-4-5-6 were cleaned on purchase and refitted, 15,000 miles ago they were replaced, only No 2 stayed put) were in immaculate order, the cylinder head also was almost totally carbon free.

"Inlet and exhaust ports are clean, valves are free from burning or pitting, all injectors chattered like 5 little chaffinches when tested @ 155 BAR, on stripping they too were free from corrosion pitting and rust, around the tip of the injector oil was visible, unusual, usually carbon would be found.

"All in all the fuel system was in immaculate order, the usual engine wear and tear was visible but not indicative of bad fuel or poor burning.

"What this exercise proves is that well-made methyl ester is every

bit as good as diesel or commercially produced biodiesel."

The specialist VW diesel engineer said he'd never seen an engine of that age looking so clean.

On 7 Nov 2002 **Graham Noyes** of **World Energy**, a major commercial supplier of biodiesel in the US and beyond, wrote to the Biofuels-biz mailing list:

"The big fear of the biodiesel industry is that homebrewers are going to destroy the market. I have seen home-brewed biodiesel cause problems in multiple locations and it has taken significant efforts to undo the damage. One region of the country in particular had large quantities of homegrown off-spec fuel that was being sold and distributed. The use of biodiesel was substantially delayed in this area until trust for the fuel was re-established."

But, put under considerable pressure, he was unable to provide any details of this catastrophe -- no details at all. Three weeks later he changed his tune:

"After some experience here, I have a much better understanding of the efforts that are being made to make top-quality fuel. I also think I should provide some more details regarding my perspective on homebrew (and should have been more careful about sweeping statements in the first place). While I do nothing but biodiesel 40-70 hours/week, I have not seen any significant problems result from the use of homebrew. There are concerns but these are primarily perception rather than experience."

An apocryphal tale, as we'd charged: just industry rumour-mongering. But Graham earned the homebrewers' respect for admitting it -- and now he works to counter such negative mythology in industry.

Some months later, in May 2003, World Energy recalled a consignment of commercial biodiesel from the Pacific Northwest because it was sub-standard, with a "high glycerine content" (ie unwashed fuel). To their credit, World Energy acted quickly to withdraw the fuel, replace it with quality fuel and repair the PR damage. But soon afterwards several thousand gallons of commercial biodiesel distributed in the San Francisco area (not by World Energy) turned out to be very poor-quality, sub-standard fuel (also unwashed, and worse) and was recalled, fortunately before it reached consumers.

Maria Alovert ("Girl Mark"), master biodiesel homebrewer, teacher and activist extraordinaire in the Berkeley area, got hold of a sample of it. This is what she wrote to the Biofuel mailing list:

"Now what's that again about homebrewers, quality, and out-of-spec fuel, and the quality control standards that only industry can provide??

"The ironic thing is that we are holding a quality control/quality testing training at our coop on Monday night. We usually use a sample of commercial fuel, a sample of acid-base homebrew, and a few samples of varying qualities of homebrew, to illustrate all the points made in the training.

"The acid-base homebrew and the commercial fuel are the standards for 'good quality'... Ironically enough, in Monday's training, the unknown, "poor quality" sample is going to be this commercial fuel.

"Homebrewers testing commercial fuel to see if we think it's actually safe to use, if it would need to be reprocessed, and otherwise passing judgement on it... it's all kind of funny to me after all the whining about homebrewer 'bad quality'."

Why quality matters

A message to one of the biodiesel discussion groups told how someone had made some biodiesel by shaking the ingredients up a few times in a bottle and put it straight into his tank: "... I've had dozens of trouble-free miles!" he enthused.

Unlike gasoline engines, diesels will run on bad fuel -- for a while: they'll run on used motor oil, or with kerosene or even gasoline added, or on sub-standard, unwashed biodiesel. But diesel motors and their fuel systems should last 250,000 miles or more -- half a million miles isn't uncommon. Dozens of miles, 10,000 miles or even 20,000 miles don't mean much. A real test would be over at least 250,000 miles on unwashed biodiesel with all its contaminants -- soaps, excess methanol, residual lye, free glycerine and all, with regular engine disassembly and full professional examination for wear. There aren't any such scientific tests, especially as standards committees and other professional bodies in several countries have already determined what damage these contaminants and impurities do -- that is the

basis of the various **national standards** for biodiesel.

Here's what the **Fuel Injection Equipment (FIE) Manufacturers** (Delphi, Stanadyne, Denso, Bosch) have to say about biodiesel quality:
Summary -- html
Full document -- Acrobat file, 104kb

Quality testing

This is the most useful all-round test, and it's very simple: Put 150 ml of unwashed biodiesel (settled, with the glycerine layer removed) in a half-litre glass jar. Add 150 ml of water, screw the lid on tight and shake it up and down violently for 10 seconds or more. Then let it settle. The biodiesel should separate from the water in half an hour or less, with amber biodiesel on top and milky water below. This is quality fuel, a completed product with minimal contaminants, well within the standard specifications. Wash it and then use it with confidence.

But if it turns into something that looks like mayonaisse (emulsifies) and won't separate, or if it only separates very slowly, with a thick white layer sandwiched between water and biodiesel, it's not quality fuel and your process needs improvement. Either you've used too much catalyst and made soap (better titration), or a poor conversion has left you with mono- and diglycerides (try more methanol, better agitation, longer processing time, better temperature control), or both.

Whichever, you're headed for washing problems. Super-gentle washing techniques might avoid the problems, but you'll still be left with poor-quality fuel laced with contaminants that are bad for the engine and the fuel system. Even normal bubble-washing is quite gentle, and it's worth repeating the test with some washed fuel -- it should separate from the water cleanly within 10 minutes.

See:
Bubble washing
How the process works

Todd Swearingen of Appal Energy in the US offers some useful D-I-Y tests: "The barnyard tests for your fuel are to take a liter of finished fuel, process it again as if it were **virgin veg oil**.

If any more glycerine drops out, then you know it wasn't as good as it could have been.

"Also, look at your wash water. The second wash should be almost completely clear. The third wash should be nearly crystal clear.

"After settling 24 hours after a third wash, the fuel should be transparent when held up to light in a glass jar. If slightly hazy, simply heating the fuel to 90 deg Fahrenheit (32 deg C) should clarify it.

"If it clarifies with minimal application of heat, throw it into your tank and go see your mum for the weekend.

"If all of the above 'tests' turn out well, you probably have a fuel that would analytically beat fuel produced using continuous process methods."

Aleks Kac has provided some useful quality tests you can do yourself:

"Diesel engines require fuel of a certain quality. You just can't pour poor-quality biodiesel into the tank and expect the engine to go on and on without problems. You have three very dangerous enemies: free glycerine, poorly converted oils/fats and sodium lye. Free glycerine and mono-, di- and triglycerids (poor ester conversion) will form gum-like deposits around injector tips and valve heads, sodium lye can damage the injector pump. The key to good fuel is to just do right and finish it! Use pure chemicals (sulfuric acid, sodium lye and methanol) and measure them accurately -- this will take care of poor conversion. A proper wash will get rid of any glycerine and neutralize the remaining lye.

"There are also kits available for various quality tests. I was told in a letter from one of the visitors to our site of a test used by the motor industry for determination of glycol in motor oil. This should work for free glycerine determination.

> "'For glycerine analysis I suggest that you get a test kit for determining ethylene glycol in motor oil. This test is simple and it generates a purple colour if substantial free glycerol is present. Just analyze the biodiesel as if it were motor oil. Used-car dealers use the test to determine if there are leaks in the cooling system. Glycol and glycerol

give the same result in the test." (With thanks to Martin Reaney)

"Paper chromatography and thin layer chromatography will tell you the conversion rate, and titration may tell you about any remaining lye.

"There is a rule of thumb: the brighter yellow in color, the better the crack. As a standard you should take virgin sunflower oil yellow color in see-through sunlight. (It's a sort of colorometry). Then take a glass jar of your fuel and place it in front of a white wall in the evening. When seen in the reflected light of a tungsten bulb it should not change to orange (a very simple case of absorbtion spectrometry).

- Nicely cracked biodiesel: very pale yellow (less than virgin sunflower oil) and no change in color with artificial lighting;
- Acceptable biodiesel: yellow like virgin sunflower oil or straw, but will get orangey undertone in reflected tungsten light;
- Deeper color biodiesel has a lot of glycerine in it in the form of various glycerids. Not good for standard engines. Remedy: If the diesel is too dark and you are sure that you used the correct quantitie(s) of catalyst(s), add a pinch more alcohol -- you could be losing it due to evaporation."

The **USDA's Agricultural Research Service** has adapted a sophisticated tool known as **Near Infrared spectroscopy**, or NIR, for testing the quality of biodiesel.The standard method is the gas chromatograph, a complex piece of equipment that needs technical expertise, takes time, and requires special chemicals. NIR is a nifty tool, which can also be used for determining fatty acid composition in vegetable oils and oil content in seeds, and needs no special training. It uses light rather than chemicals to perform the analysis, and can measure the conversion of vegetable oil to biodiesel in less than a minute.

Standards for biodiesel

Oils and esters and characteristics
Iodine Values
Quality standard for rapeseed oil fuel
Cetane Numbers
National standards for biodiesel
Fuel properties of fats and oils

Fuel properties of esters

US standard -- D6751-02 Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels. Download from the ASTM site, costs $30 (pdf):
http://www.astm.org/cgi-bin/SoftCart.exe/STORE/filtrexx40.cgi?U+mystore+mofc8213+-L+D6751+/usr6/htdocs/astm.org/DATABASE.CART/PAGES/D6751.htm

EU standard -- DIN EN 14214, Publication date:2003-11 Automotive fuels - Fatty acid methyl esters (FAME) for diesel engines - Requirements and test methods. Order from Beuth Verlag GmbH ("search" for "EN 14214")
http://www.beuth.de/index_en.php

CEN Diesel Fuel Specification (EN 590:1993):
http://journeytoforever.org/energiaweb/en590en.htm

Standard testing:
Biodiesel fuel testing for the US ASTM D-6751 standard:

Analytical Testing Services, Inc.
http://wetestit.com/

Harris Testing Laboratories, Inc.
http://www.harristestinglab.com/quote/d6751.htm

Using biodiesel in winter

Like petroleum diesel fuel, biodiesel clouds when the weather gets cold, filling with little crystals of wax that can clog the fuel filter. When it gets colder still the biodiesel gels -- sets solid and won't flow or pour. But petroleum diesel fuel, especially winterized or #1 diesel fuel, can take more cold than biodiesel can.

Here's what you can do about using biodiesel in cold weather:
Biodiesel in winter

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Food or Fuel?

A common objection to biomass energy production is that it could divert agricultural production away from food crops in a hungry world -- even leading to mass starvation in the poor countries.

True or not?

Not true: at best it's an oversimplification of a complex issue. It just doesn't work that way, and neither does hunger.

This is a sound explanation from the **Foundation for Alternative Energy** (FAE) in Slovakia:

"A major criticism often levelled against biomass, particularly against large-scale fuel production, is that it could divert agricultural production away from food crops, especially in developing countries.

The basic argument is that energy-crop programmes compete with food crops in a number of ways (agricultural, rural investment, infrastructure, water, fertilizers, skilled labour etc.) and thus cause food shortages and price increases.

However, this so-called 'food versus fuel' controversy appears to have been exaggerated in many cases. The subject is far more complex than has generally been presented since agricultural and export policy and the politics of food availability are factors of far greater importance.

The argument should be analysed against the background of the world's (or an individual country's or region's) real food situation of food supply and demand (ever-increasing food surpluses in most industrialized and a number of developing countries), the use of food as animal feed, the under-utilized agricultural production potential, the increased potential for agricultural productivity, and the advantages and disadvantages of producing biofuels.

Fuel alcohol in Brazil

The food shortages and price increases that Brazil suffered a few years ago, were blamed on the ProAlcool programme (fuel ethanol). However, a closer examination does not support the view that bioethanol production has adversely affected food production since

Food or fuel?
Straight vegetable oil as diesel fuel

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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Seeds of the world

Brazil is one of the world's largest exporters of agricultural commodities and agricultural production has kept ahead of population growth: in 1976 the production of cereals was 416 kg per capita, and in 1987 -- 418 kg per capita. Of the 55 million ha of land area devoted to primary food crops, only 4.1 million ha (7.5 per cent) was used for sugarcane, which represents only 0.6 per cent of the total area registered for economic use (or 0.3 per cent of Brazil's total area). Of this, only 1.7 million ha was used for ethanol production, so competition between food and crops is not significant.

Furthermore, crop rotation in sugarcane areas has led to an increase in certain food crops, while some byproducts such as hydrolyzed bagasse and dry yeast are used as animal feed. Some experts (Goldemberg,1992) believe that 'In fact, the potential for producing food in conjunction with sugarcane appears to be larger than expected and should be explored further'.

Food shortages and price increases in Brazil have resulted from a combination of policies which were biased towards commodity export crops and large acreage increases of such crops, hyper-inflation, currency devaluation, price control of domestic foodstuffs etc. Within this reality, any negative effects that bioethanol production might have had should be considered as part of the overall problem, not the problem.

It is important to mention that developing countries are facing both food and fuel problems. Adoption of agricultural practices should, therefore, take into account this reality and evolve efficient methods of utilising available land and other resources to meet both food and fuel needs (besides other products), e.g., from agroforestry systems."

-- From **"Renewable Energy"**, by Emil Bedi, FAE-SZOPK, Bratislava, Slovakia -- the Foundation for Alternative Energy (FAE) is a Slovak non-governmental organisation committed to environmental protection through the promotion of sustainable energy development: Biomass -- See "FOOD OR FUEL?" http://www.seps.sk/zp/fond/dieret/biomass.html
For more of Emil Bedi's excellent work, see "Energy today basics" at Hakan Falk's **Energy Saving Now** website: http://energy.saving.nu/energytoday/basics.shtml

See also **"Fuel Ethanol and Food Supply"**, Canadian Renewable Fuels Association: http://www.greenfuels.org/ethafood.html

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Starvation?

It is also often said that increased bioenergy use in the developed countries, particularly in the US, would cut US food exports and lead to starvation in the Third World.

Aside from lacking the essential analysis of food supply and demand outlined above, this argument leaves out the potential of set-aside land and marginal land, it ignores the large amounts of biomass currently wasted in various ways in the developed countries (from agricultural and forestry residues to commercial food-processing by-products to the huge amounts of waste cooking oil dumped in sewers and landfills, etc), and it relies on a mythical view of the developed nations' role in feeding the world.

These are typical objections to biomass energy production:

1. "Any attempt to grow fuel for general use would require a massive increase in crop yields at a time when we are unlikely to be able to grow enough food to feed everyone without affecting other species. To go 'green' in developed countries at the expense of food production may well result in effective genocide in other, less developed countries, even our own poor would not be exempt."
2. "Present food shortages throughout the world call attention to the importance of continuing US exports of corn and other grains for human food to reduce malnutrition and starvation. Expanding ethanol production could entail diverting essential cropland from producing corn needed to sustain human life to producing corn for ethanol factories."

There is no food shortage

The world already grows more than enough food to feed everyone. About a billion people now don't have enough food to meet basic daily needs, but that's NOT because there's not enough food. There's more food per capita now than there's ever been before -- enough to make everyone fat. There's enough to provide at least 4.3 pounds of food per person a day: two and a half pounds of grain, beans and nuts, about a pound of fruits and vegetables, and nearly another pound of meat, milk and eggs.

People starve because they're victims of an inequitable economic system, not because they're victims of scarcity and overpopulation.

It's a myth that most of the food is grown in the rich countries. The US, for instance, is the world's biggest-ever food IMPORTER. "US

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exports of corn and other grains for human food to reduce malnutrition and starvation" is another myth. Most US grain exports go to feed livestock, not humans. Much of it is also used as feedstock for industry. It can also undercut local food production, leading to less local food security, not more.

Facts

1. The US and the other industrialised countries are the world's major food importers, importing 71% of the total value of food items in world trade (Handbook of International Trade and Development Statistics 1994 (New York and Geneva: United Nations Conference on Trade and Development, 1995), table 3.2).
2. The US imports about $1.5 billion worth of beef a year (Food and Agriculture Organisation, FAO Trade Yearbook 1995, vol. 49 (Rome: FAO, 1996), 160, table 12).
3. The US imports 54% more in farm commodities than it exports (FAO Trade Yearbook 1995, table 6), much of it from countries where the majority lack a healthy diet. The US is in fact the biggest food importer the world has ever seen.

See:
The Myth of Scarcity
http://www.foodfirst.org/pubs/backgrdrs/1998/w98v5n1.html
12 Myths About Hunger
http://www.foodfirst.org/pubs/backgrdrs/1998/s98v5n3.html

US grain exports

There are many different fuel crops and many different ways of growing them, from the eco-unfriendly, chemical- and energy-intensive industrial farming methods to sustainable methods which conserve or even improve the environment, with equal or higher yields.

In the US, the main fuel crops are corn (maize), for ethanol, and soybeans producing soy oil for biodiesel. These are the crops which it's alleged should not be diverted from "human food to reduce malnutrition and starvation".

"We have the ability in the United States to grow the grain to feed the world" -- Allen Anderson, Chairman of the **MARC 2000** coalition of agribusiness and transportation interests, testimony before the Senate Agriculture, Nutrition and Forestry Committee, April 30, 1998

"Our mission is to feed and nourish a growing world population" -- **Archer Daniels Midland**, multinational grain trading company, November 22, 1999

"Helping farmers grow a wide variety of goods to feed a growing world" -- **Cargill, Inc**, multinational grain trading company, November 22, 1999

But research by Mark Muller and Richard Levins of the **Institute for Agriculture and Trade Policy** reveals a rather different picture:

- For every one ton of US corn exported in 1996 to one of the 25 countries with the world's most serious malnutrition problems (Category 5 countries, with at least 35 percent of the population undernourished), 260 tons were exported to a wealthy Organization for Economic Cooperation and Development (OECD) country.
- 20 percent of the total US corn crop is exported; two-thirds of these exports go directly to the 28 industrial OECD countries, where it is mostly used for feeding animals.
- 76 percent of the corn used in the US is used for animal feed.
- Less than three-tenths of one percent of total US corn exports went to the poor Category 5 countries in 1996.
- Less than three percent of total US corn exports in 1996 went to the 24 Category 4 countries (where undernourishment affects at least 20 percent of the population).
- More US corn goes to make alcoholic beverages in the US than is exported to feed the hungry in the world's 25 most undernourished countries combined.
- About one-third of the total US soybean crop is exported; 70 percent of US soybean exports went to 28 industrial OECD countries in 1996.
- No soybeans were exported to Category 5 countries in 1996, while 17.8 million metric tons went to OECD countries.
- In 1998, a year of record-low soybean prices, the 25 most undernourished countries received less than 0.027 percent of total US soybean exports.

See **"Feeding the World?"**
http://www.iatp.org/foodsec/library/admin/uploadedfiles/Feeding_the_World_The_Upper_Mississippi_River_.htm

"The U.S. Department of Agriculture estimates that more than a billion bushels of corn went unused last year [2000]." -- University of Wisconsin

http://www.news.wisc.edu/view.html?get=6810

The real causes of hunger

The United Nations Development Programme says the effects of globalisation and increasing economic integration have led to the rich getting richer and the poor getting poorer in nearly every way.

UN statistics provide evidence of the widening gap between rich and poor: In nine years, the income ratio between the top 20% and the bottom 20% has increased from 60:1 to 74:1. Eighty countries have less revenue than they did a decade ago. The assets of the 200 richest people exceed the combined income of 41% of the world's total population. The assets of the top three billionaires are more than the combined GNP of all least developed countries and their 600 million people. The overall consumption of the richest fifth of the world's people is 16 times that of the poorest fifth. About 840 million people are malnourished. Nearly 340 million women are not expected to survive to age 40. Nearly 160 million children are malnourished. More than 250 million children are working as child labourers.

Human Development Report 1999
http://www.undp.org/hdro/report.html
UN Human Development Report finds social inequality and poverty increasing worldwide
http://www.wsws.org/articles/1999/aug1999/un-a06.shtml

Of the world's 6 billion people, 2.8 billion live on less than $2 a day, and 1.2 billion on less than $1 a day.
Global Poverty Report: Genoa G8 Summit July 2001
http://www.worldbank.org/poverty/library/G8_2001.htm
World Development Report 2000/2001: Attacking Poverty
http://www.worldbank.org/poverty/wdrpoverty/index.htm

The true picture may even be worse -- both the World Bank and the United Nations Development Programme, which produces the annual Human Development Report, have been accused of massaging the numbers on poverty.

"Global Falsehoods: How the World Bank and the UNDP Distort the Figures on Global Poverty" by Michel Chossudovsky, Professor of Economics, University of Ottawa
http://www.transnational.org/features/chossu_worldbank.html

"World Bank dilutes report -- Agencies claim poverty document was censored" Guardian (London) September 13,

2000
http://www.guardian.co.uk/Archive/Article/0,4273,4063044,00.html

"World Bank cooks poverty statistics" by Chakravarthi Raghavan, Chief Editor of SUNS (South-North Development Monitor), Third World Network Features, August 2000
http://csf.colorado.edu/mail/homeless/2001/msg00289.html

Economic growth is projected as the road to overcome global poverty. With economic growth of $100 the rich 20% of the world population pocket $83 and the poorest 20% get $1.40. Global economic growth is therefore a highly inefficient way to help the global poor.

Wealth extraction causes poverty, and poverty causes hunger.

Fuel AND food

In any event, with most biofuels you remove the energy and are still left with the food -- or "feed" more often (for livestock). With ethanol the feed value is enhanced: the distillers dried grains by-product is more nutritious than the original unprocessed grain (because of the yeast). With biodiesel you're left with the oilseed cake after the oil has been pressed out -- again, depending on what seed is used, this is usually a highly nutritious, high-protein livestock feed.

With biofuels you CAN have your cake and eat it.

As for poor countries, local production of biofuels from locally grown crops, where appropriate, can cut dependence and cash expenditure on imported fuels, increase community self-reliance, and provide a spur for local job creation and growth. It can also cut dependence on fuel wood, which is often scarce and causes immense health problems through indoor air-pollution. And, as we've seen above, growing biofuels crops can encourage food-crop production rather than reducing it.

On a related issue, or rather non-issue, see **Is ethanol energy-efficient?**

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EN ESPAÑOL, sitio hermano para biodieseleros DIY

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What people are saying about us

The best car in the world

Karl in Britain sent this message to the **Biofuels mailing list** on 24 June 2001, at a time Americans were hurting because fuel prices were soaring towards $2 per gallon: "I don't know how you lot have the cheek to complain --- you pay bugger-all for petrol. We in the UK pay the equivalent of $6 and have been paying those sorts of prices for years. This is also typical of the rest of Europe. We just drive smaller economical well designed efficient engines rather than gas guzzling piles of crap to get around it."

This drew a heated response from across the Atlantic, though one American agreed -- Todd said: "Praying for $5.00 a gallon... and a consumer awakening..."

"Hear, hear!" said Harmon, another American. "And has anyone ever figured out why commercial users pay a cheaper rate of electric and gas? So they can waste more?"

The rest of the world also tends to think it's wasteful: the US, with less than 5% of the world's population, accounts for 25% of **world energy use** (and 36% of all greenhouse gas emissions -- see **World's top CO2 producers**). Even the OECD says US gas is much too cheap, encouraging high consumption.

Fuel Economy for New Cars Is at Lowest Level Since '80 -- New York Times, May 17: The overall fuel economy of new cars and trucks sold in America, after improving slightly a year ago, has dropped back to the lowest levels since 1980, a new government report indicates.The Transportation Department report estimates that the average fuel economy of all cars and light trucks sold in 2001 will be 24.5 miles a gallon, the same as in 1999 and slightly below the 24.7 miles a gallon in 2000. The peak was 26.2 miles a gallon in 1987, before automakers began selling large numbers of gas-guzzling sport utility vehicles.
http://www.nytimes.com/2001/05/18/politics/18FUEL.html

US drivers want better mileage when they fill up -- Christian Science Monitor, June 21, 2001: By a nearly 5-to-1 margin, Americans surveyed say they would favor a new law that would force car manufacturers to increase auto and truck fuel mileage.
http://www.csmonitor.com/durable/2001/06/21/p2s1.htm

US motorists trying to cut gas use -- Reuters, July 05, 2001: US consumers are reacting to higher gasoline prices with their wallets, according to a new Harris Poll. Half of those surveyed are cutting gasoline consumption and planning to buy more fuel-efficient cars.
http://enn.com/news/wire-stories/2001/07/07052001/reu_gaspoll_44204.asp

"We are a huge country with vast distances over which people and things must be transported," said Dana, also an American. "I just don't think most Europeans understand the rules we must live with in such a large and spread-out nation."

Peugeot 404 -- the "best car in the world"

Keith answered: "How many American miles driven are accounted for by that factor? Most are commutes, no? Sitting in the traffic, wasting all that fuel. Why should long distances equate with low efficiency? I come from a big country. No need for big cars just because you travel far. My Peugeot 404 was a great long-distance car. I once swapped it with a friend for a few days because I needed his pickup, and when we reswapped he said: 'Don't you ever have to put fuel in that thing?'"

Study finds traffic getting worse -- CNN, May 7, 2001: "The [Urban Mobility] study found the total congestion 'bill' for the 68 cities in 1999 came to $78 billion in lost productivity, 4.5 billion hours of delay and 6.8 billion gallons of wasted fuel."
http://www.cnn.com/2001/US/05/07/traffic.cities/index.html

2001 Urban Mobility Study
http://mobility.tamu.edu/

Paul, in Australia, was sparked by mention of a Peugeot 404: "Memories, memories, but then I am a Peugeot fanatic. As they say 'Engineered to be Enjoyed'. Cars designed by engineers with drivers in mind."

Keith replied: "They were GREAT, those cars! They won all the front places in all the tough African rallies every year -- Paris-Dakar, the East

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African Safari. Then they stopped making them, and the Toyotas took over. The 404 was the best car I've ever had."

Paul answered: "A copy of *Which Car* 1996 (Australia) carried a photo of a Peugeot 404 with the following caption: 'The best all-round four cylinder car seen in Australia and repeatedly named as the best car in the world by US experts. And they were right. Unbelievable suspension, amazing strength, unburstable 1.6 engine, the most sublime four-speed column shift, stainless steel trim, standard heater, enormous brakes and the best seats in the business. All for the price of a Holden poverty pack.'

"In the early days in Australia, because of the poor condition of the roads and the long distances to be covered, it was thought that heavier cars were up to the task. Australia's own, the Holden, was basically built along the lines of American cars.

"In the 1950s Redex sponsored the first Around Australia Trial. Interest was keen and there were plenty of entries. Favorites were the local Holdens and American cars. Also entered were a couple of light European cars, Peugeot 203s, their 1200cc four cylinder engines less than half the capacity of their competitors. Nobody gave them much of a chance. Imagine their surprise when the trial was won by a 203 with a couple more in the top ten.

"Power and bulk were no match for strength and endurance...

"The Peugeot 404 was at last a car that did everything I asked of it, forgave all my mistakes and just kept going. With its smallish engine and skinny wheels it could still run rings around the domestic product. It was capable of incredibly quick journeys."

Keith: "It's what a real car should be, and has been, but isn't any more. We need an updated, improved, diesel Peugeot 404 -- something worth putting our biodiesel into. Who's going to build one? American know-how, French ingenuity, German efficiency or Japanese technique?"

Peugeot 404 brochures -- 404 Berline: See "404 1969 (English)"
http://home.soneraplaza.nl/qn/prive/rh.passchier/peugeot/f44berli.html

Technical data for the 1974 Peugeot 404 GT
http://members.mcnon.com/mbrunner/peugeot/404gtdae.htm

The average fuel consumption of American cars (set in 1975) is 27.5 miles per gallon, and of light trucks 20.7 miles per gallon -- but "light trucks" includes gas-guzzling SUVs (Sports Utility Vehicles), pickups and minivans that account for about half the vehicles sold in the US. The overall average last year was 24.7 mpg. Closing the "SUV loophole" would save one million barrels of oil a day. The US consumes about 20 million barrels a day, with foreign imports accounting for more than half of the supply. US automakers oppose stricter standards. The auto industry claims 32 mpg for cars and 27 mpg for trucks by 2010 is the best they could do.

The Peugeot 404 diesel did better than that -- and that was 30 years ago.

Cheney: Bush won't change fuel standards -- V-P reassures GM execs during Tech Center tour -- The Detroit News, June 19, 2001
http://detnews.com/2001/autos/0106/19/d01-237861.htm

Panel Backed by Bush Urges Higher Fuel Efficiency for Cars -- New York Times, July 17, 2001
http://www.nytimes.com/2001/07/17/business/17AUTO.html

Bush might back stricter mileage standards -- Cheney -- Reuters, July 19, 2001
http://www.planetark.org/dailynewsstory.cfm?newsid=11637

A standard production-model German **Volkswagen Lupo 3L TDi** diesel achieved an average of 118 mpg on a recent round-the-world trip. The Lupo also broke the round-Britain economy record, previously held by a standard Daihatsu Charade diesel at 103 mpg. Volkswagen engineers are working on a super-economical motor

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that could go 300 miles on only one gallon of fuel.

But a Lupo couldn't match a Peugeot 404 in the Paris-Dakar rally. Why can't we have it both ways?

See also **Kings off the road**

Energy consumption

USA

Population: 276 million (4.6% of world total)
Per Capita Gross Domestic Product (GDP): $38,043
Total Energy Consumption: 98.8 quadrillion Btu (25% of world total)
Per Capita Energy Consumption: 355.9 million Btu
Per Capita Carbon Emissions: 5.5 metric tons of carbon
Number of People per Motor Vehicle: 1.3

European Union (EU)

Population: 375 million (6.25% of world total)
Per Capita Gross Domestic Product (GDP): $22,773
Total Energy Consumption: 61.7 quadrillion Btu (16% of the world total)
Per Capita Energy Consumption: 164.5 million Btu
Per Capita Carbon Emissions: 2.4 metric tons of carbon

Germany

Population: 82.8 million (1.38% of world total)
Per Capita Gross Domestic Product (GDP): $20,531
Total Energy Consumption: 13.9 quadrillion Btu (3.6% of world total)
Per Capita Energy Consumption: 170.4 million Btu
Per Capita Carbon Emissions: 2.8 metric tons of carbon
Number of People per Motor Vehicle: 1.9

France

Population: 59 million (0.98% of world total)
Per Capita Gross Domestic Product (GDP): $20,338
Total Energy Consumption: 10.3 quadrillion Btu (2.7% of world total)
Per Capita Energy Consumption: 173.5 million Btu
Per Capita Carbon Emissions: 1.8 metric tons of carbon
Number of People per Motor Vehicle: 1.9

Japan

Population: 126.5 million (2.1% of world total)
Per Capita Gross Domestic Product (GDP): $37,944
Total Energy Consumption: 21.7 quadrillion Btu (5.7% of world total)
Per Capita Energy Consumption: 171.6 million Btu
Per Capita Carbon Emissions: 2.4 metric tons of carbon
Number of People per Motor Vehicle: 1.8

Australia

Population: 19.2 million (0.32% of world total)
Per Capita Gross Domestic Product (GDP): $19,796
Total Energy Consumption: 4.7 quadrillion Btu (1.2% of world total)
Per Capita Energy Consumption: 249.8 million Btu
Per Capita Carbon Emissions: 4.9 metric tons of carbon
Number of People per Motor Vehicle: 1.7

India

Population: 1,014 million (16.9% of world total)
Per Capita Gross Domestic Product (GDP): $490

Total Energy Consumption: 12.2 quadrillion Btu (3.2% of world total)
Per Capita Energy Consumption: 12.3 million Btu
Per Capita Carbon Emissions: 0.25 metric tons of carbon
Number of People per Motor Vehicle: 142.9

Sudan

Population: 35 million (0.58% of world total)
Per Capita Gross Domestic Product (GDP): $311
Total Energy Consumption: 0.07 quadrillion Btu (<0.1% of world total)
Per Capita Energy Consumption: 2.3 million Btu
Per Capita Carbon Emissions: 0.04 metric tons of carbon
Number of People per Motor Vehicle: 100

Nepal

Population: 24.7 million (0.41% of world total)
Per Capita Gross Domestic Product (GDP): $1,109
Total Energy Consumption: 0.05 quadrillion Btu (<0.1% of world total)
Per Capita Energy Consumption: 2.3 million Btu
Per Capita Carbon Emissions: 0.04 metric tons of carbon
Number of People per Motor Vehicle: N/A

On a per capita basis, the US uses 5.4 times more than its fair share of the world's energy, the EU 2.6 times its share, Germany 2.6 times its share, France 2.8 times its share, Japan 2.7 times its share, Australia 3.8 times its share.

India uses one-fifth of its fair share, Sudan less than one-fifth its share, Nepal less than one-fifth its share.

The average American uses twice as much energy as the average European or Japanese and 155 times as much as the average Nepalese.

In terms of production, Americans produce more per head than Europeans and about the same as Japanese, but they use twice as much energy as the Japanese to do it.

Based on figures from:
US Energy Information Administration
http://www.eia.doe.gov/
CIA World Factbook 2000
http://www.cia.gov/cia/publications/factbook/

World's top CO_2 producers

The following countries had the highest total carbon dioxide emissions in the year 2000 (the most recent data available). Fossil-fuel burning, cement production, and gas flaring were major contributors.

Rank	Country	Carbon (Thousands of metric tons)
1.	United States	1,528,796
2.	China	761,586
3.	Russia	391,664
4.	Japan	323,281
5.	India	292,265
6.	Germany	214,386
7.	Britain	154,979
8.	Canada	118,957
9.	Italy	116,859
10.	South Korea	116,543
Sources: Gregg Marland and Tom Boden of Oak Ridge National Laboratory in Tennessee and Bob Andres of the University of North Dakota (Published in the Christian Science Monitor)		

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Diesels in the US

New cars

VW Tdi

Jetta sedan and wagon
Golf
New Beetle

VW Jetta

Mercedes

No longer sells a diesel in the US -- but Mercedes-Benz has said it will offer a diesel-powered version of its 2004 model E Class sedans on the US market.

SUVs

Ford Excursion
Chevrolet Suburban diesel discontinued in 1999

Used cars

-- from most available to least available (more or less)

VW Tdi

Jetta, Beetle, Golf, mid-90s Passat, Pickup, Vanagon

Mercedes diesels

(Sedans and wagons)
'81 to '85: 300D, SD and SDL
Earlier: 300D and 240D
The 300s were 5-cylinder, later models with turbo, the 240s all 4-cylinder non-turbo.
Later: '87 300TD wagon, 6-cylinder
'87 300SD (big body) sedan, 6-cylinder
190D, non-turbo 4-cylinder - later models may have turbo
'90's - 300D sedans and 300TD wagons went back to a 5-cylinder turbo, 300SD still had the 6-cylinder
350
Unimog truck

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EN ESPAÑOL, sitio hermano para biodieseleros DIY

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VW non-Tdi turbos and non-turbos

Jetta, Golf, Rabbit, Quantum, Dasher, Pickup, Vanagon, first diesel Rabbits from around 1979.

Others

Audi 5000 diesel 1979-83

BMW diesels:
524TD or 528TD, 1984-1985, 6-cylinder. Rare.
The same engine was used in the mid-'80s Lincoln Continential Town Car, also rare.

Volvo diesel car (VW 5-cylinder non-turbo and turbo)

Peugeot diesels:
The turbodiesel in the 505 sedans and wagons was a good engine, the non-turbo in the 504 was pokey, all rare.

Nissan Camry
Nissan Sentra
Nissan pickup (4x4 turbo diesel)

Isuzu Imark car 1.8 liter
Isuzu PUP pickup truck 2.2 liter non-turbo and turbo

Toyota Pickup
Toyota Camry

Mazda Pickup truck 1984 B2200

Mitsubishi Mighty Max Pickup truck

General Motors

The infamous Oldsmobile diesel engines made by General Motors from 1978-1985. The V8 5.7 liter was fitted to Oldsmobile sedans, Cadillacs and Chevrolets, and some pick-ups.
The V6 4.3 liter was available in smaller front-wheel-drive vehicles, eg. Cutlass Calais.
Chevrolet car (3.5L)
Chevrolet trucks (6.2L-6.5L, Duramax diesel)
Chevrolet LUV (Isuzu pickup)
Chevrolet Chevette (1.8 liter Isuzu diesel engine)

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Ford

Powerstroke diesel, from 1997 -- direct-injection, electronic controls, in pickups, vans, the Expedition, and the Excursion
Pre-1997: Ford/Navistar 7.3L V8, preceded by the Ford/Navistar 6.9L V8, both indirect injection
Ford Topaz (Mazda diesel)

Dodge trucks (Cummings diesel)\

SUVs

Chevrolet Suburban 6.2 and 6.5 GM diesel
International Scout (Nissan diesel motor)
Isuzu Trooper 2.2 liter non-turbo and turbo
Toyota Land Cruisers imported from Canada.
Chrysler Jeep (diesels brought in from Canada)
Pre-74 Land Rovers, 4 cyl. 2.5 non-turbo diesel

Coming soon

GM will be bringing out a V6 version of the Duramax for smaller vehicles (smaller than the 3/4-ton truck it comes in now).

Ford V6 4.5-liter "baby Powerstroke" for the F-150 pickup, Expedition and E-150 van, by 2005 -- could end up in SUVs

Ford is planning a clean-running diesel for the Ford Focus car for the USA.

Detroit Diesel/Allison "Delta" V6 diesel - common-rail, direct injection - to be installed in SUVs and light trucks.

Mercedes-Benz is to offer a diesel-powered version of its 2004 model E Class sedans.

VW 12-cylinder diesel, in the new VW SUV (rumored).

-- Craig Reece, Jesse Parris and Joe Martelle of the Biofuel mailing list

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Fats and oils

There's a choice to make for running diesels on biofuels:

- make biodiesel and just use it, no need to modify the engine, or
- buy a ready-made conversion system for your vehicle or build your own so you can run it on straight vegetable oil (SVO) -- no need to process the fuel, just put it in and go.

Elsbett, Germany

Does the SVO option work? Yes -- IF you go about it the right way. It's not quite that simple a choice. For one thing, if you want to use waste vegetable oil, which is often free, you're going to have to process it anyway, though less so than to make biodiesel. And it still might not be a very good fuel.

But read on -- you CAN run your diesel motor safely on straight vegetable oil, just put it in and go. There are pitfalls and provisos, but we'll help you to steer your way through them.

One of the great advantages of biodiesel is that it will work in any diesel motor -- see **Biodiesel and your vehicle**. (**More** on the choice between biodiesel and SVO.)

The same claim is often made for straight vegetable oil fuel systems, such as this: "Ready-to-install kit that will allow you to run any diesel on waste vegetable oil."

Is it true? Yes, but for how long?

Diesel motors last a long time, half a million miles or more is not unusual, and there are very few thorough, long-term studies of the effects of using straight vegetable oil in diesel motors. What is clear, however, is that "any diesel" is an exaggeration.

- Some vegetable oils are better than others.
- Some diesels are more suitable than others.
- Some injection pumps work better than others.
- Some computerized fuel systems don't like vegetable oil at all.
- There are doubts about using vegetable oil in DI (Direct Injection) diesels.
- There are also doubts about using waste vegetable oil.

(See **The TDI-SVO controversy**)

The main problem is that vegetable oil is much more viscous (thicker) than conventional diesel fuel (DERV, petro-diesel). It must be heated (thinned) so that it can be properly atomised by the fuel injectors. If it's not properly atomised, it won't burn properly, forming deposits on the injectors and in the cylinder head, leading to poor performance, higher emissions, and reduced engine life.

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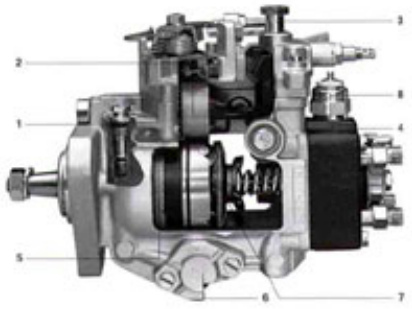
This can also happen with unsuitable oils, for instance those with a high iodine value, such as linseed oil (see **Iodine Values**), which can form tough epoxy deposits, not good for engines. It's argued that a good SVO system will prevent this, but solid proof is lacking.

"In the high temperatures commonly found in internal combustion engines, the process is accelerated and the engine can quickly become gummed-up with the polymerised oil." -- From "Waste Vegetable Oil As A Diesel Replacement Fuel": http://www.shortcircuit.com.au/warfa/paper/paper.htm

Waxes can clog up the fuel system, especially in cold weather. Waste oils can contain acids that cause corrosion in the injector pump, and impurities that can cause coking and further corrosion.

"In autumn 2001 an injection pump was damaged for the first time ... so that an exchange was necessary. The vehicle had previously been driven without problems for two years. An examination of the defective sections found substantial surface erosion of the hardened steel high pressure parts, which are not acid-proof." The problem was traced to a supply of soy oil which was not the usual food-grade oil and had a high acid-content. BioCar (German page): http://biocar.de/info/warnung1.htm



Cutaway view of an injector pump -- complex, expensive

Here's some more:

"Rapeseed oil ... can only be used as a diesel fuel extender, with inclusion rates of up to 25%." -- From "Results of engine and vehicle testing of semi-refined rapeseed oil": http://www.regional.org.au/au/gcirc/6/214.htm

And yet more:

"Deacidified rapeseed oil can be used as fuel for a diesel engine. Degummed oil and crude rapeseed oil were found to be unsuitable for use as fuel due to the high level of incombustible materials in oil." -- From "Operation of a Diesel Engine Using Unrefined Rapeseed Oil as Fuel": http://ss.jircas.affrc.go.jp/engpage/jarq/33-2/Togashi/togashi.html

Nonetheless, experience is showing that SVO systems are a practical proposition with a lot of advantages to offer, not least of all that using SVO can be cheaper than turning it into biodiesel and uses less energy than making biodiesel does.

It's vital to pay close attention to the quality and condition of the oil -- much more critical with an SVO system than if you're going to convert the oil into biodiesel. Study the resources below carefully, as well as the information on oil and fuel qualities and properties on our **Oil yields and characteristics** page.

That done, get a good system matched to the right kind of engine with the right kind of injection pump, as well as to your climate, and you'll be just fine, like thousands of others.

The following chart is a guide to safe, long-term use of vegetable oil as diesel fuel.

Guide to using vegetable oil as diesel fuel

Key

+ favored

What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox
School gardens
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– less favored

SVO = straight vegetable oil (virgin oil, fresh, uncooked)
WVO = waste vegetable oil (used cooking oil, "grease", fryer oil, including tallow, fats)

-- With information provided by Ed Beggs of Neoteric Biofuels, Inc.
http://www.biofuels.ca

Engine type
IDI (Indirect Injection) +
DI (Direct Injection) –
Newer engines are generally less tolerant of SVO.
(See **The TDI-SVO controversy**)

Injection type
Mechanical injection +
Computerized injection –

Injection pump
Inline +
Rotary –
Lucas/CAV injection pumps have had high failure rates running on SVO.

Oil type
New SVO +
WVO –
Brassicas (mustard, rapeseed, canola -- all high-lubricity oils) seem to be among the best, or at least there are more results available on using them in SVO applications.

Pre-treatment
Raw SVO pressed on-site from seed should be degummed and deacidified.
Oil must be free of water (especially WVO).
Deacidification of WVO recommended.
WVO must be pre-filtered.

Filtering (engine fuel system)
To 10 microns, preferably 5 microns or even lower.
Oil should be filtered to the specifications for the injection pump. Additional coarser, upstream filters recommended, final filter should be the same rating as original equipment.

Injection temperature of SVO
For IDI engines, the oil should be pre-heated to 70-80 deg C (160-180 deg F).
Research indicates that DI engines require much higher injection temperatures for efficient fuel atomization, but higher temperatures cause other problems. DI engines are being run with two-tank SVO systems, but it's not recommended.
Hose-in-hose heating systems using the engine coolant may not be reliable.

Maintenance
Injector inspection and cleaning if indicated.
Head removal, combustion chamber cleaning if indicated.
Lube oil sampling.
Check/change fuel filters often, especially in cold weather -- vacuum gauges can warn when filters are plugging.

Start-stop fuel
Biodiesel or petro-diesel (high-quality). The solvent properties of biodiesel and of premium petro-diesel fuels help to remove any deposits that may form. See: Fuel Quality
http://www.dieselpage.com/art0599fq.htm
Lubricity benefits

http://www.biodiesel.org/pdf_files/Lubricity.PDF

Frequency of start-stop cycle
Fewer is probably better, especially in cold weather, eg.:
Genset +
Taxi –

Load
Full load operation +
Idling –

Method
Two-tank system, start-stop on petro-diesel or biodiesel, with pre-heating of SVO + +
Single tank with SVO heating +
(for IDI genset, this may be okay, since very low number of start-stop cycles and high loads)
Unheated SVO –

SVO systems

Apart from the Elsbett system (below), the best systems use **two tanks**, one for SVO and one for diesel or biodiesel. Start up the engine on biodiesel/diesel from one tank while the SVO in the other tank is heated to at least 70 deg C (160 deg F) using the engine coolant and/or electric heating. Once it's warm enough, switch the fuel supply to the SVO tank -- and then back to biodiesel/diesel several minutes before shutting down. This flushes out the fuel system and prevents cooling SVO from clogging the injectors and filters. Extra upstream filters should be included.

Elsbett, Germany -- Full modification for running a diesel car on pure vegetable oil -- includes new injectors, glowplugs, heat exchangers, everything required. This is the truly professional system. Diesels modified by Elsbett will run on SVO, petro-diesel, biodiesel, or any blend of the three. Includes Direct Injection diesels, doesn't include diesels with Lucas-CAV rotary pumps. One-year warranty on parts as well as any proven damage to the engine resulting from vegetable oil fuel use. Warranty limited to SVO, excludes WVO, but not limited to rapeseed oil.
http://www.elsbett.com/
http://www.eco-tuning.com/ (in German)
Email: info@elsbett.com
Also exports do-it-yourself "tuning kits", on application: submit a form online for feasibility, prices, etc. Prices start from about Euro 800 (US$900).
http://elsbett.com/emotanfr.htm

Jim Burke reports on fitting an Elsbett single-tank conversion to his '98 VW A3 Jetta TDI, with Driver's Log:
http://ctbiodzl.freeshell.org/votdi.html
Pictures:
http://ctbiodzl.freeshell.org/vo_conversion.html

Elsbett Workshop -- Report on an Elsbett workshop with Elsbett engineer Alexander Noack, by Rachel Burton of Piedmont Biofuels in Pittsboro, North Carolina, USA, March 22, 2004:
http://www.biofuels.coop/blog/archives/000066.html

The **Elsbett engine** -- the 3-cylinder SVO diesel motor designed by the late Ludwig Elsbett, was a highly advanced true multifuel engine, and the forerunner of all DI diesels made today. Details:
http://www.elsbett.com/gd/eteche.htm
More detail (in German):
http://www.elsbett.com/gd/etech.htm
News article about a Mercedes fitted with the amazing Elsbett engine (120kb graphic file).

BioCar -- Dual-tank straight vegetable oil system from G. Lohmann in Munich, Germany. The patented "BioCar" computerized controller monitors and controls fuel flows and temperatures, allows use of veg-oil with the newest injection pumps, adding petro- or biodiesel before the injection pump to adjust the viscosity. Can be installed by any handiman who "can solder and read". See "List of the motor vehicle types already converted". German-language site with on-site Babelfish/Systrans translation to English and other languages. Price including computer from Euro 1,280 (US$1,250).
http://www.biocar.de/home.htm

Neoteric Biofuels Inc. in British Columbia, Canada -- Neoteric's G3 Max SVO Systems are complete two-tank systems with a range of options, from US$699. System uses inline electric heater. Also, inline G3 VEG-Therm veg-oil heaters (12-volt, self-regulating), tank heaters, veg-oil pumps, canola-based lubricants, KOMET oil presses, workshop filters and transfer pumps.
http://www.biofuels.ca

Greasel conversion kit -- "Ready-to-install kit that will allow you to run any diesel on waste vegetable oil. The key to running a diesel on vegetable oil is heat. This is done by a special tank and fuel line, heated with the hot coolant your engine is already producing." Any diesel? Maybe -- see provisos above. See also **The TDI-SVO controversy**. From $365.
http://www.greasel.com

Diesel-Therm (German pages with English version) -- ATG system, "Innovative Products and Solutions for Diesel Vehicles and Motors, Vegetable Oil-Kit, Converting Diesel-Operating Vehicles to Vegetable Oil." Uses electric continuous-flow heater.
http://www.diesel-therm.com/veggie-kit.htm

From **TäbyPressen** in Sweden: "Drive your diesel-engine with warm raw straight vegetable rape-oil" -- Skeppsta Maskin AB veg-conversion, veg-tuning -- dual-tank system with thermostat-controlled electric valve to switch to veg-oil after start-up and back to diesel on shut-down. Electric SVO heating, extra fuel filters, etc. Also small-scale oil-presses, information on using SVO, online forum and links to other forums and resources (some in English).
http://www.oilpress.com/drive_your_diesel.htm

Grease Car -- Dual-tank system with coolant heating, claims suitable for WVO use for any diesel in any climate. See provisos above. See also **The TDI-SVO controversy**. Pricey

system, from $795. Aluminum tanks are probably overkill.
http://www.greasecar.com/

Fuel heaters, filters

References

Report of the **European Advanced Combustion Research for Energy from Vegetable Oils** (ACREVO) study of the use of straight vegetable oil as diesel fuel. Investigates the burning characteristics of vegetable oil droplets from experiments conducted under high pressure and high temperature conditions. Very interesting study, worth a thorough read (4,400 words).
http://www.nf-2000.org/secure/Fair/F484.htm

"**Straighter-than-straight vegetable oils as diesel fuels**", Michael Allen, Visiting Professor, Prince of Songkla University, Thailand: What happens when you try to run a diesel motor on crude palm oil.

"**Palm Oil as a Fuel for Agricultural Diesel Engines: Comparative Testing against Diesel Oil**", by Gumpon Prateepchaikul and Teerawat Apichato of Prince of Songkla University, Thailand. Comparative tests of indirect injection agricultural engines fueled by diesel and refined palm oil and operating continuously at constant 75% maximum load and speed of 2,200 rpm.

"**Renewable Oil Fuels and Diesel Engines As Components of Sustainable System Design**" by Ed Beggs of Neoteric Biofuels -- "Are renewable oils, as fuels in unmodified compression ignition engines, a technically and economically feasible component of sustainable system design, in both developing and developed countries?" -- 196-page Master's degree thesis, 6Mb Acrobat file:
http://www.biofuels.ca/ebeggsthesis.pdf

"**Technical Overview of Vegetable Oil as a Transportation Fuel**", 1991, Charles L. Peterson and Dick L. Auld, Department of Agricultural Engineering, University of Idaho -- see section concerning Fuls, South Africa, indirect injection engines: Fuls. J., Hawkins, C.S. and Hugo, F.J.C., 1984, "Tractor Engine Performance on Sunflower Oil Fuel," Journal of Agricultural Engineering Research 30:29-35. Download (Acrobat file, 2152kb):
http://www.biodiesel.org/resources/reportsdatabase/reports/gen/19910101_gen-292.pdf

Use of Raw Vegetable Oils as Diesel Fuel Replacements -- University of Idaho: "... most research with raw vegetable oils have shown reduced engine life due to polymerization in the ring belt area and in some cases lubricating oil thickening, reduced bearing life or even sudden catastrophic failure..."
http://www.uidaho.edu/bae/biodiesel/rawoils.html

Using Unmodified Vegetable Oils as a Diesel Fuel Extender -- A Literature Review by Sam Jones and Charles L. Peterson, University of Idaho, September 2002: "When tested in long term tests blends above 20 percent nearly always result in engine damage or maintenance problems... many researchers have been involved in testing programs designed to evaluate long term performance characteristics. Results of these studies indicated that potential hazards such as stuck piston rings, carbon buildup on injectors, fuel system failure, and lubricating oil contamination (Pratt, 1980) existed when vegetable oils were used as alternative fuels... Engine tests showed that carbon deposits in the engine were reduced if the oil was heated prior to combustion. It was also noted that carbon deposit levels differed for oils with similar viscosities, indicating that oil composition was also an important factor." 4,600-word report. (Word document, 56kb):

http://www.uidaho.edu/bae/biodiesel/raw%20vegetable%20oils_literature%20review.doc

Review: Utilization of Rapeseed Oil, Rapeseed Oil Methyl Ester or Diesel Fuel -- Exhaust Gas Emissions and Estimation of Environmental Effects, by Jürgen Krahl, Axel Munack, Müfit Bahadir, Leon Schumacher and Nancy Elser, 1996. This report is a review of emissions tests of rapeseed oil and rapeseed methyl esters biodiesel using the US FTP-75 tests or European ECE-15 13 and 5 tests. Emissions are categorized and compared with petroleum diesel fuel in different types of diesel engines. Section 2 on Engine Testing Procedures and section 3, "Environmental Effects of the Main Exhaust Gas Components", are well worth a read in their own right.

"**Waste Vegetable Oil as a Diesel Replacement Fuel**" -- Informative 6,500 article by Phillip Calais, Environmental Science, Murdoch University, Perth, Australia, pcalais@ieee.org, and AR (Tony) Clark, Western Australian Renewable Fuels Association Inc, ar.clark@bigpond.com:
http://www.shortcircuit.com.au/warfa/paper/paper.htm
"**Waste Vegetable Oil Conversion of Mazda 1990 2.0L diesel station wagon**", by Tony Clark:
http://www.shortcircuit.com.au/warfa/WVOMazdaDiesel.htm
Pictures of the Mazda conversion:
http://www.shortcircuit.com.au/warfa/warfaPictures.htm

"**Biodiesel: The Use of Vegetable Oils and Their Derivatives as Alternative Diesel Fuels**", G. Knothe, R.O. Dunn, and M.O. Bagby, in Fuels and Chemicals from Biomass. Washington, D.C.: American Chemical Society. Download full-text article:
Acrobat file, 912kb
MS Word file, 212kb

"**Operation of a Diesel Engine Using Unrefined Rapeseed Oil as Fuel**", Chiyuki Togashi, Department of Agricultural Engineering, Miyagi Agricultural College, and Jun-ichi Kamide, Faculty of Agriculture, Yamagata University, Japan. Report of tests with unrefined rapeseed oil in a small diesel engine on short-term performance, long-term operation and no-load continuous operation using deacidified oil, degummed oil and crude oil.
http://ss.jircas.affrc.go.jp/engpage/jarq/33-2/Togashi/togashi.html

"**Results of engine and vehicle testing of semi-refined rapeseed oil**", Kevin P. McDonnell, Shane M. Ward & Paul B. McNulty, University College Dublin, Dept of Agricultural & Food Engineering, Dublin, Ireland.
http://www.regional.org.au/au/gcirc/6/214.htm

General information: "**Vegetable oil instead of diesel -- an alternative fuel?**" -- Stephan Helbig's very informative site, includes details on modifying motors for SVO use, similar approach to the Elsbett system.
http://people.freenet.de/sthl/poel/vegoil.htm
Using vegetable oil as a substitute for diesel fuel -- extensive **FAQ**
http://people.freenet.de/sthl/poel/VegFAQ.htm

Eignung von aufbereiteten Altfetten zum Betrieb eines Dieselmotors (Suitability of treated used fats as a fuel for diesel engines), Dipl. Ing. Olaf Soyk, 1999, 145 pages -- the "**Biocar thesis**". Acrobat file, 1305Kb, in German:
http://www.rieger-online.de/biocar/diplomarbeit_soyk.pdf
Part English translation: a summary of all important diagrams and charts of the "Biocar thesis", translated by Stephan Helbig: "There are no further comments of what is shown here. If you want to know more about the evaluation of these results, maybe contact Biocar. Biocar offers a heated dual tank vegoil conversion kit that is also made for use of solid, used

fats. Anything in this paper assumes a Biocar kit."
http://www.vegburner.co.uk/biocar.html
Biocar:
http://biocar.de/

Jim Burke's TDI vegoil conversion -- "Due to the continued price increases of biodiesel, I have decided to convert my '98 Jetta TDI to vegetable oil. The price of biodiesel has gone up over 40% in a little over a year. A kit was recently made available from Elsbett Technologie for vegetable oil conversion of TDIs. Assuming I use waste fryer oil and my time is free, I should recover the cost of the kit in just over one year. I'll document my experiences here."
http://ctbiodzl.freeshell.org/votdi.html

"**Research into Biodiesel Kinetics and Catalyst Development**", by Adam Karl Khan, Department of Chemical Engineering, University of Queensland, 17 May 2002: Some useful information on SVO -- Acrobat file, 432Kb:
http://www.cheque.uq.edu.au/ugrad/chee4001/CHEE400102/Adam_Khan_Thesis.pdf

Comparison of Transport Fuels -- Final Report (EV45A/2/F3C) to the Australian Greenhouse Office on the Stage 2 study of Life-cycle Emissions Analysis of Alternative Fuels for Heavy Vehicles, by Tom Beer, Tim Grant, Geoff Morgan, Jack Lapszewicz, Peter Anyon, Jim Edwards, Peter Nelson, Harry Watson & David Williams -- CSIRO in association with The University of Melbourne, the Centre for Design at RMIT. Parsons Australia Pty Ltd and Southern Cross Institute of Health Research.
http://www.greenhouse.gov.au/transport/comparison/index.html
Part 1 provides a summary of the salient points of each fuel, Part 2 consists of detailed chapters on each fuel.
Executive Summary - (Acrobat file 186Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/execsummary.pdf
Part 1 Canola - (Acrobat file 12Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/1ch5.pdf
Part 2 Canola - (Acrobat file 24Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/2ch5.pdf

There's a helpful **FAQ** at the **Neoteric Biofuels Inc** website:
http://members.shaw.ca/biofuels/faq.html

"**Vegetable Oil as a Fuel**" by Darren Hill -- book-length online report, mainly UK-based: The Diesel Engine, Theory of Vegetable Oil Use as a Fuel, Engine suitability, Heating the Oil, Biodiesel, Micro Emulsions and Blends, Vegetable Oil Engine Design, Vegetable Oil Furnaces and Heaters, Oil Types and Filtering, Taxation, Implications of Vegetable Oil Fuel Use, Sources. Darren welcomes contributions from users.
http://www.vegburner.co.uk/report.html

SVO Database -- for vehicles running on SVO (straight vegetable oil), or a blend of SVO. Users can enter their own information according to vehicle type, pump, fuel system used, etc. Good and bad experiences welcome. Open access with free password. Hopes to show which vehicles are the most successful based on mileage and quality of fuel used.
http://www.vegetableoildiesel.co.uk/fuelsdatabase/database/index.php

Using jatropha oil as fuel -- a selection of interesting papers at the **Jatropha Website**, along with lots of other material on the uses and benefits of the wonderul *Jatropha curcas* tree. See "Literature":
http://www.jatropha.org/

Honge Oil as diesel fuel in India

http://www.goodnewsindia.com/Pages/content/discovery/honge.html

SVO vs biodiesel in Europe

Much of the work with SVO as a fuel has been done in Northern Europe, and there's much valuable information to be found there. But (again!) -- in a word, beware. Some Northern Europeans simply chuck it in and go -- no dual-tank systems, no pre-heating, no modifications at all, and they claim high mileages with no trouble.

Maybe so, but note the provisos listed above. And also be aware that they generally don't use waste vegetable oil, it's usually new, virgin oil, most often rapeseed oil, one of the best oils for fuel use. An older Mercedes IDI diesel might manage it, but others probably won't.

Also, there's quite a lot of mis- or disinformation, especially about SVO vs biodiesel.

A Northern European gent sent a message to the **Biofuels mailing list** which caused widespread derision and amusement, and some anger. He was pushing the use of "pure plant oils", but ignored all the caveats on using SVO, and added some serious nonsense about biodiesel to strengthen his case for pure plant oils:

"Biodiesel is a chemically altered plant oil. However the process to chemically change the structure of Pure Plant Oil is a very costly operation and requires a lot of energy, as it removes the glycerine substituting it by methanol as well as adding other chemicals, making the end-product poisonous and equally hazardous as fossil diesel fuel."

He was referred to the comprehensive, much corroborated tests in the US that found that biodiesel is "less toxic than table salt, more biodegradeable than sugar", to the **U.S. Department of Energy study** at the University of California at Davis, which found a 93.6% lower risk of cancer from biodiesel emissions than from petro-diesel, to life-cycle and economic studies of biodiesel production that found the opposite of his cost and energy claims, and to **this picture** at our website.

Asked to support his claims, he descended into accusation and denial, and then unsubscribed from the list. It turned out he was about to open a factory producing "pure plant oil" fuel.

Such stories of the alleged horrors of biodiesel are not uncommon in Northern Europe, especially on websites promoting SVO. It seems partly to stem from an apparent misclassification of water pollution standards in Germany, where the risk from rapeseed oil is not even classified, whereas biodiesel is a class 1 hazard, and fossil diesel is in class 2 (worse). It only refers to water pollution and no other aspects of toxicity or hazard.

A biodiesel spill is less of a problem than a spill of vegetable oil, which coats everything, like fossil oil does. In fact biodiesel is used to clean up marine oil spills. In North America it is not classed as hazardous goods.

"All the biodiesel fuels are 'readily biodegradable' compounds according to EPA standard (EPA, 1982) and have a relatively high biodegradation rate in the aquatic environment... Biodiesel can promote and speed up the biodegradation of diesel. The more biodiesel present in a biodiesel/diesel mixture, the faster the degradation rate. The biodegradation pattern in a biodiesel/diesel mixture is that microorganisms metabolize both biodiesel and diesel at the same time and at almost the same rates... Neat rapeseed oil and soybean oil have slightly lower percent degradation. Their higher viscosity may limit their solubility, therefore limit their biodegradability." -- From "**Biodegradability of Biodiesel in the Aquatic Environment**", by Xiulin Zhang, Charles L. Peterson, Daryl Reece, Gregory Möller, Randall Haws, University of Idaho, Moscow, Idaho, USA.
http://www.biodiesel.org/resources/reportsdatabase/reports/mar/mar-009.pdf

This is corroborated by other studies.

You'll encounter a few such yarns being spun at the European sites listed below. Here's another one:

"Biodiesel is chemically produced and substantially more expensive than vegetable oil. Except for a few new vehicles, most are not suited for using biodiesel. The majority of diesel vehicles must first be converted, in order to guarantee they will operate on biodiesel. The problem is the durability of the plastic and rubber components, which come into contact with the fuel. If biodiesel is used in a system that has not been adapted, the fuel can leak from places where it frequently backs up, which weakens and dissolves the fuel system's components. When using pure, untreated vegetable oil, these problems will not occur." -- From Diesel-Therm.
http://www.diesel-therm.com/

That it's "untreated" is a myth -- most oils have to be de-gummed, deacidified, and usually winterized, it also involves chemical treatments, and there are centralized factories in Europe that do this for fuel-grade vegetable oil, much the same as for food-grade oils. Very few types of oil can go straight from the oilseed crusher to the fuel tank. (See "**Straighter-than-straight vegetable oils as diesel fuels**".)

Also, the introduction of low-sulphur diesel fuel in Europe about 10 years ago caused severe problems for fuel systems and all manufacturers hastened to correct it, which also made the vehicles safe for biodiesel. In effect, no European cars made in the last 10 years have fuel-system parts that are susceptible to rot from biodiesel use. Also, all French diesel fuel now contains 2-5% biodiesel (partly to make up for the lack of lubricity in low-sulphur diesel fuel), and European diesel cars can and do use it safely, as with Japanese diesels. See: **Stanadyne White Paper on diesel fuel** -- "Low-Sulfur Diesel Fuel Requires Additives to Preserve Fuel Lubricity":
http://fiss.com/rm/firm0015.htm

If you're in any doubt, check the resources linked from our **Biodiesel resources on the Web** page, and make up your own mind.

A German professor compared Plant oil (SVO) and Biodiesel (BD), including these comparisons:

Comparison of pure plant oil and bio diesel as fuel		
	SVO	**BD**
Production		
principle	decentralized small oil expellers	central, big industrial units
Environment		
biol. degradation	very fast	delayed
danger of water pollution	no	small
human toxicity	regularly no or small	toxic
Social acceptability		
strategy	small, decentralized	big, central
logistics	simple	complex
transportation	short distances	long distances
regional income generation	high	low

-- From "Comparison of pure plant oil and bio diesel as fuel" by Prof. E. Schrimpff, Fachhochschule Weihenstephan, University of Applied Sciences, "the largest 'green' university of applied sciences in Germany".
http://jatropha.org/p-o-engines/svo-bd-characteristics.htm

And it's all baseless, fact-free nonsense. Biodiesel production is not confined to "central, big industrial units" (as thousands of small, local operations will attest). SVO cannot be used straight from the expellor and is often produced in big centralized factories in Europe. SVO does not biodegrade "very fast", biodiesel biodegrades faster, not "delayed". Biodiesel poses less danger of water pollution, not more. It is no more toxic than SVO.

In some real applied science, a different professor concludes: "So dear friends, please be careful when you compare that lovely (but already refined) SVO with biodiesel." -- From "**Straighter-than-straight vegetable oils as diesel fuels**", Michael Allen, Visiting Professor, Prince of Songkla University, Thailand

A **Biofuel mailing list** member put it in perspective: "SVO versus biodiesel is a pseudo argument that should not exist. It creates a false competitive situation between two good things and distracts from the real issues on how we can minimize the use of fossil fuels."

Quite. They're complementary, it's a choice.

Further discussion:

Vegetable Oil Based Bio Fuel Choices
http://archive.nnytech.net/index.php?view=19802&list=BIOFUEL

A few calculations on SVO and homebrew biodiesel
http://archive.nnytech.net/index.php?view=22528&list=BIOFUEL
http://groups.yahoo.com/group/vegoil-diesel/message/2136
http://groups.yahoo.com/group/vegoil-diesel/message/2131
http://groups.yahoo.com/group/vegoil-diesel/message/2137
http://groups.yahoo.com/group/vegoil-diesel/message/2140

European SVO resources

Some of these sites are also listed above under "SVO systems" or "References". Many European sites have English versions. Or use these translation sites:

AltaVista -- World / Translate
http://babel.altavista.com/

Google Language Tools
http://www.google.com/language_tools

Report of the **European Advanced Combustion Research for Energy from Vegetable Oils** (ACREVO) study of the use of straight vegetable oil as diesel fuel. Investigates the burning characteristics of vegetable oil droplets from experiments conducted under high pressure and high temperature conditions. Excellent study, worth a thorough read (4,400 words).
http://www.nf-2000.org/secure/Fair/F484.htm

Elsbett, Germany -- Full modification for running a diesel car on pure vegetable oil -- includes new injectors, glowplugs, heat exchangers, everything required. This is the truly

professional system. Diesels modified by Elsbett will run on SVO, petro-diesel, biodiesel, or any blend of the three. Includes Direct Injection diesels, doesn't include diesels with Lucas-CAV rotary pumps. One-year warranty on parts as well as any proven damage to the engine resulting from vegetable oil fuel use. Warranty limited to SVO, excludes WVO, but not limited to rapeseed oil.
http://www.elsbett.com/
http://www.eco-tuning.com/ (in German)
Email: info@elsbett.com
Also exports do-it-yourself "tuning kits", on application: submit a form online for feasibility, prices, etc. Includes heavy-duty trucks with DI diesels, doesn't include DI passenger cars.
http://elsbett.com/emotanfr.htm

BioCar -- "The mother of all D-I-Y kits for vegetable oil and fat in unmodified diesel engines." Advanced dual-tank straight vegetable oil system from G. Lohmann in Munich, Germany. The patented "BioCar" computerized controller monitors and controls fuel flows and temperatures, allows use of veg-oil with the newest injection pumps, adding petro- or biodiesel before the injection pump to adjust the viscosity. Can be installed by any handiman who "can solder and read". See "List of the motor vehicle types already converted". German-language site with on-site Babelfish/Systrans translation to English and other languages. Not a cheap system.
http://www.biocar.de/home.htm

TäbyPressen, a Swedish company making small-scale oil-presses, has much information on SVO, online forum and links to other forums and resources (some in English). Also supplies Skeppsta Maskin AB veg-conversion kits.
http://www.oilpress.com/index.html

General information: "**Vegetable oil instead of diesel -- an alternative fuel?**"
http://people.freenet.de/sthl/poel/vegoil.htm
Using vegetable oil as a substitute for diesel fuel -- extensive **FAQ**
http://people.freenet.de/sthl/poel/VegFAQ.htm

Finland: 1,800 hours and seven years on mustard oil in a farm tractor:
http://personal.inet.fi/yritys/ekolaiho/mustarddiesel.html

Diesel-Therm (German pages with English version) -- ATG -- Innovative Products and Solutions for Diesel Vehicles and Motors -- also supplies Vegetable Oil-Kit SVO system:
http://www.diesel-therm.com/

Datenbank des Forums '**Fahren mit Salatöl**' (Database of the forum 'driving with salad oil') -- This German database has information on more than 300 cars using veg-oil.
http://www.poeltech.de/database/

Folkecenter for Renewable Energy, Denmark -- Plant oil technology -- modification of standard diesel engines: Running cars on pure plant oil
http://www.folkecenter.dk/plant-oil/plant-oil_en.htm

Ökologisch ohne Ökosteuer (German page with English version) -- "I drove with pure salad oil for the next 12,000km... I didn't make any changes on my car at all. I'm driving, driving and driving... for already 189,000km." Believe it or not. His photographs sure don't look too good.
http://www.rerorust.de/

http://valenergol.free.fr
http://www.pro-ev.de
http://www.fnr.de

http://www.pflanzenoelinitiative.de
http://www.bioenergie.inaro.de

Diesel information

How Diesel Engines Work
http://www.howstuffworks.com/diesel.htm

Diesel Engines (Chevron)
http://www.chevron.com/prodserv/fuels/bulletin/diesel/L2_6_fs.htm

Diesel Fuels -- Technical Review (Chevron)
http://www.chevron.com/prodserv/fuels/bulletin/diesel/L1_toc_fs.htm

So, This is Your First Diesel
http://www.dieselpage.com/art1110fd.htm

Breaking in a Diesel Engine
http://www.ford-diesel.com/contents/getitems.php3?Breaking%20in%20a%20Diesel%20Engine

Diesel Injection Systems
http://www.dieselpage.com/art1110ds.htm

Bosch -- Past, Present and the Future
http://www.dieselpage.com/art0898pf.htm

20 Questions with Racor
http://www.dieselpage.com/art1021ra.htm

20 Questions with Stanadyne
http://www.dieselpage.com/art0898sg.htm

Robert Bosch type VE Diesel injection pump -- how it works, illustrations
http://www.cs.rochester.edu/u/jag/vw/engine/fi/injpump.html

Fats and oils

The Fats and Oils: a General View, by Carl L. Alsberg and Alonzo E. Taylor, 1928, Food Research Institute, Stanford University, California
First in a series of five Fats and Oils Studies published in the 1920s by the Food Research Institute. Good overview of the subject written in layman's terms, covers nature and sources of fats and oils, properties, technology, production, international trade and more. Not very much has changed since then, it's just grown more complex. A clear and informative guide -- useful information for anyone making biodiesel or working with SVO. Full text online at the Biofuels Library.

Oils -- King's American Dispensatory, by Harvey Wickes Felter, M.D., and John Uri Lloyd, Phr. M., Ph. D., 1898
http://www.ibiblio.org/herbmed/eclectic/kings/olea.html

Chemical Reactions of Oil, Fat and Fat Based Products
http://alfa.ist.utl.pt/~fidel/creac/reac.html

Food Fats and Oils (1994) -- online book (Acrobat file, 1.3Mb):

http://www.iseo.org/foodfatsoils.pdf

Minor Oil Crops, B.L. Axtell from research by R.M. Fairman, Intermediate Technology Development Group, Rugby, UK, FAO Agricultural Services Bulletin No. 94, Rome, 1992, ISBN 92-5-103128-2: Part I - Edible oils, Part II - Non-edible oils, Part III - Essential oils -- Full text online:
http://www.fao.org/inpho/vlibrary/x0043e/x0043e00.htm

Liberty Vegetable Oil Company lists the fatty acid composition of their oils as well as other details such as the Iodine Value, SG, Flash point etc -- Sweet Almond Oil, Pecan Oil, English Walnut Oil, Hazelnut Oil, Macadamia Nut Oil, Soybean Oil, Oleic Sunflower Oil, Canola Oil, Peanut Oil, Sunflower Oil, Corn Oil, Safflower Oil, Soybean Oil (Non-GMO), High Oleic Oils including Canola and Safflower.
http://www.libertyvegetableoil.com/products.html

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Biofuels

Biofuels Library
Biofuels supplies and suppliers

Biodiesel
Make your own biodiesel
Mike Pelly's recipe
Two-stage biodiesel process
FOOLPROOF biodiesel process
Biodiesel processors
Biodiesel in Hong Kong
Nitrogen Oxide emissions
Glycerine
Biodiesel resources on the Web
Do diesels have a future?
Vegetable oil yields and characteristics
Bubble washing
Biodiesel and your vehicle
Food or fuel?
Straight vegetable oil as diesel fuel

Ethanol
Ethanol resources on the Web
Is ethanol energy-efficient?

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The TDI-SVO controversy

We've said there are doubts about running DI (Direct Injection) diesels on vegetable oil using the usual two-tank pre-heating systems. Others say so too.

Yet others say it's not an issue, it works fine.

Which is right?

Pro

"There is no issue with DI's and SVO. I'm convinced that DI engines on a heated 2-tank system are reliable. At 170 deg F, different types of oil don't display large differences in operation. Unlike cold oil."
-- Steve Spence, Webconx
http://www.green-trust.org

Greasel in the US says of their two-tank kit: "Ready-to-install kit that will allow you to run any diesel on waste vegetable oil. The key to running a diesel on vegetable oil is heat. This is done by a special tank and fuel line, heated with the hot coolant your engine is already producing."
http://www.greasel.com

"Recent DI engines are best being run on two-tank systems as vegoil might either destroy the piston or get between cylinder & piston as unburned particles or because of bad spray of the injectors (which then hit the rim of the piston or the cylinder wall). When the vegoil is warm, there is no problem with DIs. So far for a short overview..."
-- Stephan Helbig
http://people.freenet.de/sthl/

"For dual tank vegetable oil fuelled operation, with heated tank & if COLD, fuel line, I would recommend ANY diesel engine providing that the oil is hot before it hits the injector pump and is purged before shutdown. The problems with DI diesel engines seems to be mostly associated with carbon build-up on injectors and that can be reduced significantly if not eliminated by use of heated veg-oil."
-- Tony Clark, President of the Western Australian Renewable Fuels Association, Inc.
http://www.shortcircuit.com.au/warfa/warfa.htm

Con

Today's DI and TDI diesels are efficient, clean-burning engines. The fuel injection technology is highly sophisticated:

"... Siemens, Delphi and Bosch all are ramping production of sophisticated new injectors that can handle today's sky-high fuel pressure, and inject infinitesimal fuel droplets so quickly that upcoming diesels may at times employ as many as five distinct injections for each cylinder's combustion 'event.'

"... the most promising advantage of common-rail technology is the ability to deliver extremely high fuel pressures on the order of 23,000 psi (1,600 bar) or more. This type of pressure means that in microseconds, astonishingly tiny fuel droplets can be injected; these droplets more effectively mix with the induction air, boosting power production and reducing emissions.

"Only Volkswagen AG, Europe's diesel volume-sales leader, has resisted the common-rail development path, instead relying on its unique 'unit injector' system that combines each injector with an integral fuel pump, energized by its own lobe on the camshaft. This system develops pressures of up to 29,300 psi (2,020 bar)..."
-- From "**Super Diesels!**", Ward's Auto World, September 1, 2001
http://industryclick.com/magazinearticle.asp?magazineid=50&releaseid=8418&magazinearticleid=118355&siteid=26

"The latest multi-jet direct injection system with fuel supply by 'common rail' at a pressure of 1600 bar is another noteworthy feature. Fuel supply to the five-hole nozzles is controlled via an ultramodern solenoid valve. The fuel injection system's response time is less than 20 millionths of a second, ensuring extremely fine metering of the fuel and up to five injections per working cycle." -- **The Opel Eco-Speedster**
http://www.autointell.com/News-2002/October-2002/October-2002-1/October-02-02-p5.htm

Five distinct injections for each cylinder's combustion "event"... fuel pressures on the order of 23,000 psi... astonishingly tiny fuel droplets... five-hole nozzles... millionths of a second...

With such technology, fuel viscosity and combustion characteristics would have to be critical. "At 170 deg F (76.6 deg C), different types of oil don't display large differences in operation." True?

This is from a recent study:

The properties of canola oil and diesel are very similar, except a significant difference in viscosity, with canola oil having 12 times the viscosity of diesel. Even after heating to around 80 deg C it is still six times as viscous as diesel. This leads to problems with flow of oils from the fuel tank to the engine, blockages in filters and subsequent engine power losses. Even if preheating is used to lower the viscosity, difficulties may still be encountered with starting due to the temperatures required for oils to give off ignitable vapours. Further, engines can suffer coking and gumming which leads to sticking of piston rings due to multi-bonded compounds undergoing pyrolyses. Polyunsaturated fatty acids also undergo oxidation in storage causing gum formation and at high temperatures where complex oxidative and thermal polymerisation can occur.

To date there have been many problems found with using vegetable oils directly in diesel engines (especially in direct injection engines).

1. Coking and trumpet formation on the injectors to such an extent that fuel atomisation does not occur properly or is even prevented as a result of plugged orifices,
2. Carbon deposits,
3. Oil ring sticking,
4. Thickening and gelling of the lubricating oil as a result of contamination by vegetable oils, and
5. Lubricating problems.

Other disadvantages to the use of vegetable oils and especially animal fats, are the high viscosity (about 11 to 17 times higher than diesel fuel), lower volatilities content which causes the formation of deposits in engines due to incomplete combustion and incorrect vaporisation characteristics... At high temperatures there can be some problems with polymerisation of unsaturated fatty acids, this is where cross-linking starts to occur between other molecules, causing very large agglomerations to be formed and consequently gumming occurs.

Although some diesel engines can run pure vegetable oils, turbocharged direct injection engines such as trucks are prone to many problems.

-- From "**Research into Biodiesel Kinetics and Catalyst Development**", by Adam Karl Khan, Department of Chemical Engineering, University of Queensland, 17 May 2002 -- Acrobat file, 432Kb:
http://www.cheque.uq.edu.au/ugrad/chee4001/CHEE400102/Adam_Khan_Thesis.pdf

With the current injector technology, what would "large differences in operation" mean, exactly?

A well-known French study found large differences, using a DI engine:

"Fuel structure and characteristics have been shown to have great influence on engine performance and emission behaviour. One of the most important parameters is the spectrum of fatty acids. Length of carbon chains and number of double bonds in the fuel molecules affect low temperature suitability, spray formation and carbon residue. Net calorific value and density also affect the energy content of cylinder charge.

"It is possible to preheat the oil up to 150 deg C where it attains the same viscosity as the diesel oil. Atomisation tests showed that at 150 deg C the performance of the rapeseed oil are comparable with that of the diesel oil."

That's double the temperature the two-tank systems use.

The ACREVO study found that the temperature could be reduced by adding ethanol:

"It has been established that an addition of 9% of ethyl alcohol (95%) brings a great benefit regarding the pre-heating oil temperature. In fact, the presence of alcohol allows a reduction in the inlet oil temperature from 150 deg C to 80 deg C. Moreover, the combustion of the emulsion produces less soot and, at the exhaust, the amount is almost one half less than that produced by the combustion of rapeseed oil (almost 40% less soot than diesel fuel)."

But we haven't yet heard of anyone using an ethanol additive with two-tank heated SVO systems on a DI diesel. There has been some discussion of thinning the oil with "white spirit", which can mean different things in different places, but it seems inconclusive.

"**Advanced Combustion Research for Energy from Vegetable Oils (ACREVO)**":
http://www.nf-2000.org/secure/Fair/F484.htm

In the early 1980s, the German company Elsbett developed an advanced all-new DI car diesel engine which had true multi-fuel capabilities -- it could run on vegetable oil as well as petrodiesel. This engine was the forefather of the modern DI car diesels in production today.

Elsbett modifies diesels, including DI diesels, to run on vegetable oil, with new injectors, glowplugs, heat exchangers and more -- with full warranty. Diesels modified by Elsbett will run on SVO, petro-diesel, biodiesel, or any blend of the three, without dual tanks or switching fuels for start-up and shut-down.
http://www.elsbett.com/

Elsbett supplies D-I-Y kits, and recently added kits for DIs. See **Jim Burke's TDI vegoil conversion** -- "Due to the continued price increases of biodiesel, I have decided to convert my '98 Jetta TDI to vegetable oil. The price of biodiesel has gone up over 40% in a little over a year. A kit was recently made available from Elsbett Technologie for vegetable oil conversion of TDIs. Assuming I use waste fryer oil and my time is free, I should recover the cost of the kit in just over one year. I'll document my experiences here."

http://ctbiodzl.freeshell.org/votdi.html

Can DI diesels run safely on two-tank heated systems? "Two-tank systems definitely do not work for DI diesels," Klaus Elsbett told us. "The main engine breakdown reason is related to the lube oil, especially on turbocharged engines."

While Stephan Helbig said DI engines are best run on two-tank systems, he was perhaps comparing it with "just put it in and go" without heating and only one tank, as some people in Germany do that, or claim to. Maybe they get away with it with older Mercedes IDI diesels.

Stephan also said this: "Problem with TDIs is: If used with cold vegoil (which happens mostly just after cold starts) the injectors might get clogged or sooted and they can spray onto the rim of the piston or the cylinder wall. The piston might be burned away or particles might remain on the cylinder wall and cause a seizure. So two-tank system would be recommendable until further improvements are found... There have been several people who broke down even with 'ordinary' Bosch VE pumps -- not yet with TDIs. But as TDI pumps have still smaller spaces at their pistons the danger is much higher. Most recent theory is: This vegoil causes a much higher pressure on top of the pump piston. This gets compressed, widens and so gets stuck or seizes in its cylinder. As it is revolving at the same time the strain is tremendous. What helps is either a two-tank system or an instant heater to get vegoil with a low viscosity as soon as possible. And always avoid high revolutions. A distributor pump piston does twice as many strokes as the engine speed (2000rpm = 4000 strokes). So increasing the pressure might not be recommendable IMHO. Some of our pumps have done 20 or 30,000 km (12,500-18,500 miles) and then broke down because of that one common failure."

Stephan's website says this:

Newer Diesel Injection Systems:
All newer diesel engines are direct injectors. Direct injection comes with a much higher fuel pressure than pre-combustion engines. Mostly the fuel is sprayed into a hollow on top of the piston. A correct adjustment of the injection/ignition timing is very important to avoid the fuel be sprayed onto the rim of the piston or even the cylinder wall. Both can cause severe damages. Also use only heated vegoil to prevent the injectors from getting clogged up which can cause a wrong spray pattern as well.
Direct injector engines can be equipped with in-line pumps, distribution pumps or one of the other systems, mentioned in the next paragraph.

1. Pump injector units:
A single piston on top of every cylinder is driven by the camshaft (engine) and a solenoid nozzle opens the (hole-type) injector at time of ignition. Up to now there are only a few experiences with this system, but the principle suggests that it could be resistant to vegetable oil. As they produce a very high pressure of up to 1200 bar, the fuel gets hot and a heat exchanger is used to cool it down. One could make use of it to heat the vegoil and so lower its viscosity.

2. Common Rail Systems:
A high pressure is generated by fuel pumps and stored in a common injector rail. A solenoid nozzle opens the injector at the time of ignition. The pressure in the pipes is always at the same level, controlled by a regulator valve. Problems are likely to arise from the high pressure pump and the regulator valve. Again, I haven't heard about any long time experiences by now.

Vegetable oil instead of diesel -- an alternative fuel?
http://people.freenet.de/sthl/poel/VegFAQ.htm

Stephan added the following in an email on 24 September 2003:
"I am still recommending a two-tank system for DIs. Experiences have turned out that you can indeed use a single-tank system provided you can (pre)heat the injectors. There's one man who's offering heated injectors for about EUR125/item (about US$144) so EUR500 for a 4-cylinder (US$575). If you can heat the injectors and perhaps also the high-pressure compartment of the injector pump (Bosch VE/VP) by an extra heater, you can run your DIs on 100% fresh or used vegoil on a one-tank system. The problem resulting from bad spray and unburned fuel can also be solved this way. A dual tank system is just the technically less demanding (and maybe cheaper) way for DIs."

So far this has mainly been about using new oil, but Greasel and others say "any diesel on waste vegetable oil", which is a different matter.

This is what Ed Beggs of SVO system supplier Neoteric Biofuels Inc. in Canada said about it:

Re TDI: I get a lot of people, especially in the USA, determined to run brand new TDI's and PowerStrokes on WVO!

I tell them not the best idea. They insist. Fine, free country, I guess, but at least go two-tank, and get the best WVO you can find, and then also thin it out 10% or so with a suitable solvent blending agent. That's the best advice I can give to somebody who insists on doing this.

For the TDI crowd, well, if you really insist on doing this, then get that oil clean, get it thinned out a bit per ACREVO, and use a 10-micron filter, then get the oil hot, on a two-tank setup.

Your car is already very fuel efficient, and very clean. If you can afford a newer diesel, you can afford either new SVO, diesel, or good biodiesel, and if you run biodiesel, we'll still gladly sell you a VEG-Therm inline fuel heater for the winter!

So, would I myself run one of our kits on a coveted TDI of my own, one of these days, when I can afford one?

Yes I likely will, but it will be when the engine is out of warranty, the car has 100,000 km on it already and is depreciated, and it will be very good used Canola oil only, two tank, heated, and thinned, and I'll use the 10-micron filter. That much of a chance I'll take, but personally, not more than that.

-- Ed Beggs, **Neoteric Biofuels Inc**
http://www.biofuels.ca/

Conclusion

There is an "issue" with using straight vegetable oil in a DI diesel, especially waste oil. We don't say "Don't do it!", but we don't recommend it either. On the other hand, we'd like to encourage it, because unless people are prepared to take intelligent risks and experiment we'll never know what works and what doesn't. But, it is a risk, you're on your own, no guarantees.

Also, the more people use straight vegetable oil, with whatever system, good or bad, the more likely it is that the car manufacturers will start to take some notice and begin to realize that there is a market for true multi-fuel capability diesel engines, and put some R&D effort into it at last.

Here's someone who's using SVO with his DI and seems to be doing well, so far:
http://home.t-online.de/home/strutzberg
See "Salatöl - Tdii" (with English page)

He seems to be using more than just the usual two tanks and heating. "Over 60,000km..." -- 37,000 miles, good going, but still not very much for a diesel. When he makes it to 250,000, he'll have proved something, if he keeps proper records, but still not that much: that engine, under those conditions, with that system, using that oil. But it'll help.

If a lot more people do that, and keep records, then we'll eventually have enough data to make some confident assertions. But in establishing what works and what doesn't work, some are likely to be left with the remains of what didn't work. They'll be heroes in the cause of real straight vegetable oil diesel motors, that anyone can use, not just enthusiasts -- manufacturer-made, supplied and warranted diesels that can run on petro-diesel, biodiesel or straight vegetable oil, in any blend, without any fuel-switching or fuss: fill 'er up, switch on and go, stop and switch off, like any other car. Currently only the Elsbett system does that.

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Straighter-than-straight vegetable oils as diesel fuels

Michael Allen
Visiting Professor
Prince of Songkla University
Thailand

Message to the Biofuels-biz mailing list, 8 October 2002

Some background on Southern Thailand agriculture

Here in southern Thailand the major agricutural products are rubber (and rubber-wood) and palm-oil. Prawns are grown in ecologically disastrous ponds when the price is right. Rice is not extensively grown locally because the climate produces only two good crops a year.

Two-wheeled diesel tractor running on SVO in Thailand

The highly photogenic Asian water-buffalo has been largely replaced by the diesel-powered two-wheeled tractor.

Fishing is also a sizable industry and uses diesel engines attached to a long-shafted propeller (the "long-tail") for in-shore fishing or big grunty diesels in purpose-built vessels for long-line squid fishing etc.

Farmers and fishermen have experimented with SVO and SVO blends with kerosene for many years now but both refined coconut oil and refined palm-oil can be sold at a price which is comparable with diesel. Reliable facts on pollution and engine damage produced by crude vegetable oil (CVO ... Crook Vegetable Oil?) experimentation are hard to come by due to the general enthusiasm of the proponent entrepreneurs who are naturally somewhat coy about discussing their failures.

In August 2000, I was asked if "straight" palm-oil could be used to run diesel engines. Based on some work with which I was associated in New Zealand, I assured my colleagues at the Prince of Songkla University that it could. (Hell! We had fired up

diesels on butter and biogas in New Zealand! I was on a sure thing here!)

So we ran a Kubota diesel on 50:50 SVO:petrodiesel, then 80:20 and then 100:0. Based on this, we applied for financial support to find out just how much refining was (un)necessary to make an acceptable diesel fuel. Over a year, we ran seven diesel engines on palm-oil: three were in field tests on actual tractors or fishing boats, one was in a home-made truck which delivers fertiliser off-road, and three were in test-beds here at the University. They were all identical in design: And they all had to be run in on petro-diesel because they were all equally new.

In the test beds, we used a standard test based on the Japanese standards for agricultural diesels. (I don't have the designation to hand.) The only engine modification was to bring the exhaust out through the fuel tank and fit a small plastic tank and associated valves to start up the engine (and shut it down) on petrodiesel. We measured fuel economy under a variety of engine loads (achieved with an alternator and electric light bulbs.) We looked at air pollution and volumetric efficiency amongst other parameters. After 500 hours of continuous use, we shut them down, took them to bits, re-weighed the engine pieces (valves, pistons, rings, bearings) and examined them visually.

And now the bit that you are all interested in: The engines worked just fine on refined palm oil. That is oil which has been de-gummed with phosphoric acid and had fatty acids removed by saponification with sodium hydroxide. Yes folks! Sadly, you do need some chemicals and simple process engineering to make most vegetable oils work. Just because you don't do it in the back-yard doesn't mean that it has not been done -- perhaps in one of those big centralised processing plants we all despise :-)

We discontinued the trial after 2000 hours of running (with the engine hardly missing a beat). Now, as I said, the process of refining puts the finished product into a price category comparable with the retail price of petrodiesel (including some tax). In Thai currency, this is about 12 to 13 baht/litre with diesel oscillating around 14 to 16 baht/litre depending somewhat on who the US is threatening today.

To the oil farmer, his crude palm oil (CPO or perhaps CVO if you prefer to distinguish it from the SVO even though it is actually "straighter than straight") may be worth only 2 or 3 baht/litre so quite obviously, the less refining needed, the more competitive it should be (at least in an economic sense). But CPO may contain between 2 and 14% Free Fatty Acids (FFA) whereas refined palm oil contains less than 1% (usually about 0.5%). CPO is like "Brasso" metal cleaning fluid -- yellow and waxy with suspended stearin. Refined palm oil is a clean and bright liquid.

Carrying out the comparable continuous engine trials with CPO, our first engine lasted less than 300 hours before it packed in with a big cloud of black smoke and an even bigger bang. Dismantling the engine showed erosion around the inlet port and on the piston head itself. The rings were worn and CPO in the lubricating oil had apparently polymerised to a thick black treacle. So we refurbished the engine with

new parts from the maker, replaced the oil, ran it in on petrodiesel and repeated the experiment. This time it almost made it to 550 hours before the same thing happened.

Looking for suitable low-tech solutions which the farmer or a village co-operative could work with, I explored the use of a centrifuge to remove the stearin. (It was implicated in the erosion problem along with the FFA and it tended to block the fuel filter.) Well, leaving aside the question of whether a centrifuge of the cream separator variety is really low-tech, density differences between CPO and stearin were too small to get separation without close temperature control.

And so we came to biodiesel. As it happens, there are several 1 tonne units operating already in this area of Thailand (though I doubt that they comply with anyone's Health & Safety Regulations). They, of course, use waste cooking oil as their feedstock. And the technology is indeed more complicated than simply squishing the stuff out of a handful of palm-nuts in a low-tech press. But it is quite comparable with the process needed to refine CPO into SVO.

This year we have been concentrating on processes which will produce a decent fuel from high free fatty acid crude palm oils. I think we have succeeded. (In part due to Keith and "Journey to Forever" which gave us a head start.) Anyway, we are just starting our engine tests on a bunch of new motors and The New Fuel.

So dear friends, please be careful when you compare that lovely (but already refined) SVO with biodiesel. SVO is indeed a great fuel, particularly for old fashioned stationary engines with a fixed load, eg diesel electric generators or pumps for water irrigation. But you are kidding yourself if you think that the oil or coconut palm actually provides it in the form and composition that you need for this task.

Jatropha, Jojoba and Soy may be much more obliging in this respect but I can assure anyone interested that you will be unable to back up your ute to a palm-tree for refuelling in at least the next couple of years. But I also want to assure you that, even as we speak, we are working on it!

Michael Allen

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Ethanol

Ethanol (ethyl alcohol, grain alcohol), according to the US Department of Energy's National Renewable Energy Laboratory, is a "clear, colorless liquid with a characteristic, agreeable odour" -- and taste, some would add.

The Vanguard flying team uses ethanol fuel.

This is the drinkable alcohol, the active ingredient in beer, wine and spirits. Methanol (methyl alcohol, wood alcohol) is the poisonous one.

Ethanol is also a high-performance motor fuel that cuts poisonous exhaust emissions and is better for the environment.

Henry Ford designed the famed Model T Ford to run on alcohol -- he said it was "the fuel of the future". The oil companies thought otherwise, however -- but the oil crisis of the early 1970s gave ethanol fuel a new lease of life.

The Model T Ford was built to run on ethanol.

Henry Ford

The US now uses more than 15 billion gallons of cleaner, ethanol-blended petrol a year, totalling 12% of fuel sales in the US. Most of it is a 10% blend, but 85% and even 95% blends are now being tested.

Ethanol blends are increasingly used in South Africa, while Brazil, the world leader, produces four billion gallons of ethanol a year: all Brazilian fuel contains at least 24% ethanol, and much of it is 100% ethanol (engines can be designed to run on 100% ethanol).

Chrysler, Ford, and General Motors all recommend ethanol fuels, and nearly every car manufacturer in the world approves ethanol blends in their warranty coverage.

Over two trillion miles have been driven on ethanol-blended fuels in the US since 1980.

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Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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What is ethanol?

Ethanol is made by fermenting and then distilling starch and sugar crops -- maize, sorghum, potatoes, wheat, sugar-cane, even cornstalks, fruit and vegetable waste.

The benefits

Ethanol is a much cleaner fuel than petrol (gasoline):

- It is a renewable fuel made from plants
- It is not a fossil-fuel: manufacturing it and burning it does not increase the greenhouse effect
- It provides high octane at low cost as an alternative to harmful fuel additives
- Ethanol blends can be used in all petrol engines without modifications
- Ethanol is biodegradable without harmful effects on the environment
- It significantly reduces harmful exhaust emissions
- Ethanol's high oxygen content reduces carbon monoxide levels more than any other oxygenate: by 25-30%, according to the US EPA
- Ethanol blends dramatically reduce emissions of hydrocarbons, a major contributor to the depletion of the ozone layer
- High-level ethanol blends reduce nitrogen oxide emissions by up to 20%
- Ethanol can reduce net carbon dioxide emissions by up to 100% on a full life-cycle basis
- High-level ethanol blends can reduce emissions of Volatile Organic Compounds (VOCs) by 30% or more (VOCs are major sources of ground-level ozone formation)
- As an octane enhancer, ethanol can cut emissions of cancer-causing benzene and butadiene by more than 50%
- Sulphur dioxide and Particulate Matter (PM) emissions are significantly decreased with ethanol.

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Backyard ethanol

As with biodiesel, you don't have to be a corporation to make ethanol -- you can make fuel alcohol in your backyard, and many people are doing just that, and running their vehicles on clean-burning alcohol instead of gasoline.

It's more equipment-intensive than biodiesel. You need a still, and you need to learn how to ferment beer. You can build your own still, and there's good information available to help you learn what you need to know.

You'll find everything you need in our **Resources** section and in the **Biofuels Library**.

Get great advice and share information on the **Biofuel mailing list** -- the biggest and fastest growing alternative fuels mailing list on the Internet.

Permits: In the US, home brewers need to get a "small fuel producer" permit from the US Bureau of Alcohol, Tobacco and Firearms. It is fairly easy to acquire, and denaturing is not required for ethanol consumed on premises. BATF Alcohol Programs -- FAQs, Information, Permits, Regulations: http://www.atf.treas.gov/alcohol/index.htm

How does it work?

Ethanol is a very high octane fuel, replacing lead as an octane enhancer in gasoline.

Fuels that burn too quickly make the engine "knock". The higher the octane rating, the slower the fuel burns, and the less likely the engine will knock.

When ethanol is blended with gasoline, the octane rating of the petrol goes up by three full points, without using harmful additives.

Adding ethanol to gasoline "oxygenates" the fuel, adding oxygen to the fuel mixture so that it burns more completely and reduces polluting emissions such as carbon monoxide.

Ethanol and ETBE oxygenator, made from ethanol, are much safer than the toxic and polluting MTBE fossil-fuel-derived

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oxygenator used by oil companies.

Production

Ethanol fuel production is a good locally-based industry, providing local jobs and a market for local materials, and helping to keep money and investment within the community. That's why so many of the farming states in the US (and Canada) back ethanol fuel.

One ethanol plant owned by farmers in Minnesota processes 11,751 bushels of grain a day to produce 33,990 gallons of ethanol and 95 tons of high-protein livestock feed.

If you happen to have a spare acre in your back yard, you can raise enough maize to make enough ethanol to drive even a gas-guzzling Land Rover (17.5 miles per gallon) about 5,000 miles, along with enough animal feed to help keep you in eggs and chicken.

If the climate favours sugarcane, an acre's worth will take you nearly 15,000 miles. A few fruit trees would help a lot too. You could put the by-product in a digester, along with other organic wastes, to produce methane gas for cooking -- or as a heat source for the distillation process.

Alcohol yield tables (for 30 different feedstocks), showing: Average yield of 99.5 percent alcohol per ton; Average yield of 99.5 percent alcohol per acre.

Energy balance

Ethanol is a highly efficient fuel. A study by the Institute of Local Self-Reliance in the US found that using the best farming and production methods, "the amount of energy contained in a gallon of ethanol is more than twice the energy used to grow the corn and convert it to ethanol".

The US Department of Agriculture says each BTU (British Thermal Unit, an energy measure) used to produce a BTU of gasoline could be used to produce 8 BTUs of ethanol.

The non-profit American Coalition for Ethanol says ethanol production is "extremely energy efficient", with a positive energy balance of 125%, compared to 85% for gasoline, making

ethanol production "by far the most efficient method of producing liquid transportation fuels".

See:
Is ethanol energy-efficient?
Food or fuel?

Ethanol resources on the Web

Ethanol -- schools projects
See Biofuels > Biodiesel > Ethanol

Biofuels

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Ethanol resources on the Web

Some of the resources here have more to do with drinking than driving, but the homebrew hooch specialists make good ethanol of high purity, though generally in smaller quantities, and some of the most knowledgeable people on the subject and best resources on distilling are found among the homebrewers.

The StillMaker: designed for booze, but it makes 190-proof alcohol.

Proof and percent: The "proof" measure is double the percentage volume of pure alcohol. Thus 100-proof spirit contains 50% alcohol by volume, 200-proof is 100% pure.

Forums
General information
Small-scale ethanol
Ethanol from cellulose
Ethanol biodiesel
Hooch
Ethanol and your car
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Forums

The **Biofuel mailing list** run by Journey to Forever is the biggest and fastest-growing alternative fuels mailing list. An information-sharing resource for the growing number of people all over the world who are making their own fuel or would like to. Ethanol and biodiesel, also covers other alternative fuels and energy issues in general. List URL:
http://groups.yahoo.com/group/biofuel

Subscribe to Biofuel

enter email address

Powered by groups.yahoo.com

Search the **Biofuels archives** -- 37,000 entries from discussions by biofuellers all over the world:
http://infoarchive.net/sgroup/biofuel/

Distillers mailing list -- On distilling for the bottle rather than the fuel tank. "Dedicated to the exchange of information and experiences relating to the process of producing alcohol at home. Especially suited to spirit distillation."
Subscribe: distillers-subscribe@yahoogroups.com
Unsubscribe: distillers-unsubscribe@yahoogroups.com
Post message: distillers@yahoogroups.com
List URL: http://groups.yahoo.com/group/distillers
Distillers list archives: http://archive.nnytech.net/
FAQ and other information: http://homedistiller.org

New_distillers mailing list -- for newcomers.

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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The workhorses

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Internet interaction
Finding your way

Subscribe: new_distillers-subscribe@yahoogroups.com
Unsubscribe: new_distillers-unsubscribe@yahoogroups.com
Post message: new_distillers@yahoogroups.com
List URL: http://groups.yahoo.com/group/new_distillers
Distillers list archives: http://archive.nnytech.net/
FAQ and other information: http://homedistiller.org

General information

Steve Spence's **Renewable Energy Resources** site -- "the Discussion and Educational Resource for Renewable, Sustainable Home Built Energy Production" -- has a good set of fuel ethanol resources.
http://ww2.green-trust.org:8383/ethanol.htm

Ethanol in Brazil, from the International Liquid Biofuels Congress held in Brazil in July 1998 (Acrobat file)
http://www.biodiesel.org/resources/reportsdatabase/reports/gen/19980722_gen-249.pdf

"**Making Ethanol from Sugar Cane in Brazil**" by Isaias de Carvalho Macedo, from "Energy As An Instrument for Socio-Economic Development", UNDP, 1995 -- Case study of the "large-scale" production of fuel ethanol from sugar cane in Brazil from the perspective of job creation. Ethanol production has provided nearly 700,000 jobs in Brazil, 75% of them direct jobs. The so-called "large scale" biomass conversion to energy is in fact a large collection of small-scale systems; in the Brazilian case, this corresponds to the scale of agriculture generally... The ethanol programme has been an important factor in creating job opportunities, in both more and less developed regions of Brazil. In some regions, it has been remarkable at evolving from lower to higher-quality jobs, reducing seasonal unemployment, increasing wages and social benefits, and introducing new technologies in a timely way.
http://www.undp.org/seed/energy/policy/ch10.htm

Institute for Local Self-Reliance
http://www.ilsr.org/
The Institute for Local Self-Reliance (ILSR) is a 23-year old organization that works with both the public and private sectors in the US on economic development through the efficient use of local resources.

Carbohydrate Economy Clearinghouse (CEC)
http://www.carbohydrateeconomy.org/
Created by the Institute for Local Self-Reliance (ILSR) to provide up-to-date information spanning all facets of the carbohydrate economy, "from paints and inks to fuels and construction materials". Search huge resources of news, information, reports and studies on ethanol and other biofuels:
http://www.carbohydrateeconomy.org/ceic/Search2/search.cfm

Small-Scale Ethanol Production -- United States Department of Agriculture National Agricultural Library Quick Bibliography Series, 135 references, published 1992.
http://www.nal.usda.gov/afsic/AFSIC_pubs/qb92-46.htm

Ethanol FAQ from the Agricultural Technology Centre, Alberta Agriculture, Food

Schools projects
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Biofuels
Solar box cookers
Backpack stove
PicoTurbine
Low-tech radio
What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox
School gardens
School composting
Trees and forests
The Beach House fish pond
HOMeR
Eco-footprint
School and youth programs on the Web
Education resources on the Web
Children's poetry

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To Midori Hiraga
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Homepage
http://journeytoforever.org/

Handmade Projects
Ichijima
Japan

and Rural Development, Canada: What is Ethanol? -- Why Ethanol? Technical Feasibility, Renewability, Environmental Benefit, Cost Effectiveness -- What are Some Problems With Ethanol?
http://www.agric.gov.ab.ca/engineer/ana_ethanol.html

ethanol-crfa.org Canada: Ethanol and Your Vehicle
http://www.ethanol-crfa.ca/vehicle.htm
Ethanol FAQ
http://www.ethanol-crfa.ca/faq.htm

A complete report covering all of the applications of ethanol in gasoline, in new and used engines: ERDC Project No 2511 **"Intensive Field Trial of Ethanol/Petrol Blend in Vehicles"**. This trial showed no harm to any engines, and documented the benefits. This is the **Executive Summary**, compliments of Apace Research Ltd -- 10 pages, 32kb Acrobat file.

Sustainable Minnesota's Biofuels Resources
http://www.me3.org/issues/ethanol
Sustainable Minnesota (Minnesotans for an Energy-Efficient Economy -- ME3) is a coalition working for a sustainable energy future. The web site is run by the Institute for Local Self-Reliance (ILSR) and focuses on a broad range of energy issues including biomass, climate change, ecological tax reform, electric restructuring and renewable energy technologies. Links to thousands of resources.

The **Ethanol Information Centre** at Canada's Greenfuels -- Renewable Fuels Website has a large selection of factsheets and FAQs on ethanol.
http://www.greenfuels.org/ethindex.html

The **Governors' Ethanol Coalition**
http://www.ethanol-gec.org
Started by Nebraska's Governor, the GEC now includes 22 US states promoting ethanol use. News, information, bulletins, links.

Ethanol Alert! -- quarterly news bulletin produced by the Governor's Ethanol Coalition. Archives:
http://www.ethanol-gec.org/ethalert.htm
Ethanol Source, one-page bulletins on special issues:
http://www.ethanol-gec.org/ethsourc.htm
Ethanol studies and reports, by GEC and others:
http://www.ethanol-gec.org/publicat.htm
Email subscriptions to all publications:
http://www.ethanol-gec.org/subscribe.html
News release archive:
http://www.ethanol-gec.org/newsr.htm
(search engine under construction)

Renewable Fuels Association
http://www.ethanolrfa.org
The US national trade association for the domestic ethanol industry. Links, news, technical reports, general information. The RFA publishes the Ethanol Report, a bi-weekly newsletter -- Archives:
http://www.ethanolRFA.org/pubs_arch.html
Subscribe: send request for Ethanol Report by email to info@ethanolRFA.org

Search, site-wide or Ethanol Report only:
http://www.ethanolrfa.org/searchRFA/iaquery.exe

American Coalition For Ethanol (ACE)
http://www.ethanol.org
Ace is a non-profit membership association devoted to promoting the increased production and use of ethanol. "We've got a great product that is beneficial for the environment and the economy and we want everyone to know about it." Good resouces on ethanol -- studies, reports, news, links, good hyperlinked FAQ.
http://www.ethanol.org/Information/ethanol_information.htm

Nebraska Ethanol Board
http://nebsspc.nrc.state.ne.us/
What's new, Information, Events, Legislation, useful set of links

The Revenoor Co. -- Interesting, 3,500-word introductory article on producing alcohol as a fuel, from veteran distiller Terry Wilhelm.
http://revenoor.com/

Open Directory Science: Technology: Energy: Renewable: Biomass and Biofuels -- listings of biofuels information sites, biodiesel, ethanol, and more.
http://dmoz.org/Science/Technology/Energy/Renewable/Biomass_and_Biofuels/

The **Bioenergy** Mailing List searchable hypertext archives.
http://www.crest.org/discussiongroups/index.html

US Energy Information Administration
http://www.eia.doe.gov

The **US Department of Energy** has upgraded their website, so many bookmarked documents may prove to be unavailable. General biofuels portal:
http://www.ott.doe.gov/biofuels/publications.html#bioethanol
Biofuels -- Document Database search:
http://www.ott.doe.gov/biofuels/document_database.html

Biofuels information from the **US Department of Agriculture** and the **Agricultural Research Service** (ARS) Biofuels Research Program -- main focus on biodiesel and ethanol: Production and Use of Biofuels, Production of Raw Materials (Crops), Economic Research, Market Research, Pros and Cons, Getting Started in Biofuels, Funding Opportunities, News and Events, Links.
http://www.nalusda.gov/ttic/biofuels/res.htm

The **National Renewable Energy Laboratory** (NREL) is the U.S. Department of Energy's premier laboratory for renewable energy and energy efficiency research, development and deployment. NREL is operated for the U.S. Department of Energy by Midwest Research Institute,
http://www.nrel.gov/
NREL Search and Site Directory:
http://www.nrel.gov/search.html

The **Alternative Fuels Data Center** is a one-stop shop for all your alternative fuel and vehicle information needs. This site has more than 3,000 documents in its

database, an interactive fuel station mapping system, listings of available alternative fuel vehicles, links to related Web sites, and much more.
http://www.afdc.doe.gov/
Alternative Fuels Data Center Document Search
http://www.afdc.nrel.gov/cgi-bin/doc_search/searchora.cgi
Alternative Fuels Data Center -- search the AFDC Web site:
http://www.afdc.nrel.gov/search.html

Comparison of Transport Fuels -- Final Report (EV45A/2/F3C) to the Australian Greenhouse Office on the Stage 2 study of Life-cycle Emissions Analysis of Alternative Fuels for Heavy Vehicles, by Tom Beer, Tim Grant, Geoff Morgan, Jack Lapszewicz, Peter Anyon, Jim Edwards, Peter Nelson, Harry Watson & David Williams -- CSIRO in association with The University of Melbourne, the Centre for Design at RMIT. Parsons Australia Pty Ltd and Southern Cross Institute of Health Research.
http://www.greenhouse.gov.au/transport/comparison/index.html
Part 1 provides a summary of the salient points of each fuel, Part 2 consists of detailed chapters on each fuel.
Executive Summary - (Acrobat file 186Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/execsummary.pdf
Part 1 Hydrated Ethanol - (Acrobat file 39Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/1ch6.pdf
Part 2 Hydrated Ethanol - (Acrobat file 282Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/2ch6.pdf
Part 1 Diesohol - (Acrobat file 35Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/1ch7.pdf
Part 2 Diesohol - (Acrobat file 146Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/2ch7.pdf
Part 1 Anhydrous Ethanol - (Acrobat file 32Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/1ch13.pdf
Part 2 Anhydrous Ethanol - (Acrobat file 69Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/2ch13.pdf
Part 1 Petrohol - (Acrobat file 36Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/1ch14.pdf
Part 2 Petrohol - (Acrobat file 96Kb)
http://www.greenhouse.gov.au/transport/comparison/pubs/2ch14.pdf

Grades of ethanol -- what they are, what they mean, from Pharmco Products
http://www.pharmco-prod.com/pages/alcoholintro.html

Small-scale ethanol

"**Understanding Ethanol Fuel Production and Use**", by Cliff Bradley & Ken Runnion, Technical Paper # 3, Understanding Technology Series, Volunteers In Technical Assistance (VITA) -- 7,000-word article on small-scale ethanol production, with bibliography. Volunteer co-authors Bradley and Runnion specialize in alcohol fuel production technologies at Renewable Technologies, Inc.
http://www.vita.org/publications/technology.htm

Distillation - How it works, by Mike Nixon -- all is explained, clear and simple guide. (Acrobat File)
http://ww2.green-trust.org:8383/distill_howitworks.pdf

See **The Compleat Distiller** by Mike Nixon and Mike McCaw

Ethanol Curriculum for Teachers (Grades 9-12)
http://www.nwicc.cc.ia.us/etsp.htm
"Ethanol -- As A Fuel", comprehensive study project from the Northwest Iowa Community College, including laboratory production of ethanol.

See **Ethanol yield tables**

See **How-to books**

Ethanol from cellulose

"**Wood-Ethanol Report**: Technology Review", Environment Canada 1999 -- good overview of the problem and the current solutions on offer. Go to the **Biofuels Library**.

Fuel From Sawdust -- by Mike Brown (from Acres, USA, 19 June 1983): Conversion of cellulose, such as sawdust, cornstalks, newspaper and other substances, to alcohol -- "a fairly uncomplicated and straightforward process". Go to the **Biofuels Library**.

Arkenol Inc. is a pioneer in processing cellulose biomas into ethanol: agricultural wastes, straw, leaves, grass clippings, sawdust or old newspapers. The company uses proprietary concentrated acid hydrolysis technology and is in the final development stages for a 48 million litre per year biorefinery in Sacramento, California processing rice straw.
http://www.arkenol.com

The **Iogen Corporation** of Canada is "the leader in developing and manufacturing ethanol-from-cellulose". The Iogen process is an enzymatic hydrolysis process for converting lignocellulosics to ethanol -- uses steam explosion pretreatment pioneered by the company and Iogen's proprietary enzymes.
http://www.iogen.ca/

BC International Corporation uses a genetically modified organism to produce ethanol from biomass wastes such as agricultural residues, municipal waste, and forest thinnings. Two-stage dilute acid hydrolysis process for the preparation of the sugar streams and two separate fermentations although both use the same organism.
http://www.bcintlcorp.com/

"**Ethanol Production in Hawaii**", a "pre-feasibility" study who a focus on ethanol from cellulose. Includes comparison of the different processes: simultaneous saccharification and fermentation; concentrated acid hydrolysis, neutralization and fermentation; ammonia disruption, hydrolysis and fermentation; steam disruption, hydrolysis and fermentation; acid disruption and transgenic microorganism fermentation; concentrated acid hydrolysis, acid recycle and fermentation; and acidified acetone extraction, hydrolysis and fermentation.
http://www.hawaii.gov/dbedt/ert/ethanol/ethano94.html
Good list of references:
http://www.hawaii.gov/dbedt/ert/ethanol/refs.html

Genencore & DOE Move Closer to Fuel Ethanol from Biomass Cellulose - See:

Biomass Conversion with Enzymes:
http://www.newuses.org/EG/EG-23/23genetic.html

Mustard Plants Produce Low-Cost Enzymes for Making Ethanol -- Researchers at the University of Colorado (CU) at Boulder have developed a potentially low- cost method of producing the cellulase enzyme for converting woody biomass materials into ethanol.
http://www.colorado.edu/PublicRelations/NewsReleases/2001/1244.html
New Research May Reduce Renewable Fuel Costs
http://ens-news.com/ens/may2001/2001-05-24-09.asp

And here's one that went **wrong**, and could have gone horribly wrong:
http://www.safe2use.com/ca-ipm/01-02-05-report.htm

Ethanol biodiesel

Making ethyl-esters biodiesel using ethanol is a tricky process, not as simple as making methyl esters with methanol. But it can be done -- the following technical papers are available online in our Biofuels Library, and there's sound advice below from a master home-brewer who routinely makes his own ethyl-esters biodiesel**.**

Optimization of a Batch Type Ethyl Ester Process -- a recipe for biodiesel from ethanol (which you can make yourself), instead of methanol (which is toxic, fossil-fuel derived, and you can't make it yourself).

Production and Testing of Ethyl and Methyl Esters, University of Idaho, Dec 1994.

Transesterification Process to Manufacture Ethyl Ester of Rape Oil by Roger A. Korus, Dwight S. Hoffman Narendra Barn, Charles L. Peterson, and David C. Drown, Department of Chemical Engineering, University of Idaho, Moscow, Idaho, USA (Acrobat file, 672Kb)

Making and Testing a Biodiesel Fuel Made From Ethanol and Waste French-Fry Oil by Charles L. Peterson, Daryl Reece, Brian Hammond, Joseph C. Thompson, Sidney Beck, University of Idaho, Idaho, USA (Acrobat file, 2.4Mb)

Biofuels mailing list member Ken Provost, who has much experience making ethyl esters, sent us the following tips&tricks sheet.

Ethanol-based Biodiesel

1. Get plenty of experience making biodiesel with methanol before you try it with ethanol. Get comfortable titrating your oil for FFAs (free fatty acids); you'll need to do that when you use ethanol.

2. Try to find a source of KOH (potassium hydroxide) to use instead of lye with ethanol. Lye (NaOH, sodium hydroxide) will work, but it dissolves VERY slowly in ethanol. You'll need to use more of either one -- 7g per liter of clean oil with NaOH, 10g per liter of clean oil with KOH. More as required per your titration level.

3. Your ethanol will have to be EXTREMELY dry. 199-proof or higher. "Absolute" ethanol. Any more than one half of one percent water can kill the reaction.

Denaturants like methanol, isopropyl alcohol, MIBK, etc., are fine. But no water. Ethanol that dry is difficult to find cheap, especially in the US. If you want to try to make it yourself, you'll need molecular sieve, quicklime, or something else to do a "chemical" drying. Distillation alone can't get the water under 5% -- still way too much. (See below -- Anhydrous ethanol)

4. If you're interested in ethanol for environmental reasons, be careful. Even if you find anhydrous ethanol, it may come from fossil fuel. The denatured alcohols used by painters, or in other industrial applications, may be anhydrous but still derived from petroleum. In fact, since fermentation uses water, it's cheaper to make 200-proof starting with petroleum. The only way to know is to call the original manufacturer of the formula. Ask if the ethanol is "synthetic" or "fermentation". One type of denatured anhydrous ethanol that is almost always fermented is "fuel-grade", which is 199-proof denatured with gasoline. It's what they add to gasoline to make gasohol.

5. Your oil will also have to be EXTREMELY dry. Heat the oil to 120 deg C (248 deg F) and hold it there until you can turn off the flame and see the bubbling stop almost immediately. You might want to throw in some clumping cat litter (bentonite clay) and/or silica gel to scarf up any remaining water, let it settle half a day, and take the oil off the top. Sometimes that's still not dry enough. Remember -- any more than 0.5% water can kill the reaction.

6. Your oil will have to be fairly low in FFAs. You'll want to do a titration on every batch to make sure. Anything over 2 ml titration (using 0.1% NaOH solution) can cause failure of the glycerine to separate -- under 1 ml is a good idea. Most waste oil is too high, and either needs to be refined with NaOH first, or cut with clean oil to neutralize FFAs.

7. You need to use more ethanol to get full conversion. Somewhere between 275 and 300 ml per liter of oil is about right for most oils. Coconut oil will need more, maybe 350 ml. Theoretical is about 180 ml per liter, and the rest is excess to drive the reaction all the way.

8. Even when you do all the above, getting the glycerine to separate is a matter of good luck and fervent prayer. Sometimes separation occurs just like a methanol batch. Other times you won't start seeing a glycerine layer for 3 or 4 hours, or maybe overnight. Then again, sometimes it NEVER separates. Until you get separation, you haven't made biodiesel. I've heard of folks who don't wait for separation -- they just pour the whole mess right into the tank, or do some kind of water wash and think it's good biodiesel. It might burn, but it's not biodiesel. It must separate.

9. If it doesn't separate, you can sometimes force it by adding some methoxide mix. You can also make it more likely to separate by including some methanol with the ethanol right from the start. For example, you could try using an initial mix of 5 to 7 parts ethanol and 1 part methanol. Give it a few hours to separate. If it doesn't, add some straight methoxide to the kettle, using enough methanol to bring the alcohols ratio down to 3:1 eth:meth, and containing another 2g of KOH per liter of oil. That usually initiates separation within an hour. Fresh, refined edible oil might even work the first time with straight ethanol. If you use a mixture of ethanol and methanol, you can get away with 275 ml of initial mix per liter of oil.

10. If you're not scared off yet, Good Luck!
-- Ken Provost

Anhydrous ethanol

To make ethyl esters the ethanol must be anhydrous, 99%+ pure -- with less than 1% water content. The purest ethanol that can be produced by ordinary distillation is only 95.6% pure, the rest being water, which interferes with the transesterification reaction in making ethyl esters. More common for home distillation is 170-190 proof -- 85-95% pure.

Members of Journey to Forever's Biofuels mailing list have succeeded in making ethyl esters using 85% ethanol they've distilled themselves, by removing the excess water with quicklime (CaO). See "The Manual for the Home and Farm Production of Alcohol Fuel" by S.W. Mathewson, **Chapter 12 -- Drying the Alcohol**, Drying with lime.

An easier method is to use 3A zeolite molecular sieve. Biofuels group member Ken Provost reports: "Zeolite (aka 'molecular sieve') works BEAUTIFULLY to suck the last bit of water out of distilled ethanol. I got a sample of Type 3A Molecular Sieve from **Adcoa** in Southern California:
http://www.thomasregister.com/olc/adcoa/molecula.htm

"I got a can of the 4-8 mesh -- little balls of rock about 1/8" diameter. They absorb about 20% of their weight of water over the course of a few hours. Take a liter of 95% ethanol, throw in 250g of the stuff, swirl occasionally, filter out the next day through a strainer, and presto! Anhydrous ethanol. Not expensive either -- US$2.05 a pound in 10 lb quantities, and reusable indefinitely. You drive off the water under a broiler for an hour."

An alternative is to run the ethanol vapours through 3A molecular sieve in a column during the distillation process.

Cornmeal Adsorber for Dehydrating Ethanol Vapors -- by Michael R. Ladisch et al., Laboratory of Renewable Resources Engineering, Purdue University. About half the ethanol now produced in the US is dried using corn grits. When the corn's drying capacity is worn out, it can be fermented and distilled to make more ethanol. This 1981 paper is the original work on the subject.

Separating Ethanol From Water -- by Renaldo V. Jenkins of Langley Research Center, Hampton, Virginia, USA. More economical methods of separating water from ethanol to produce anhydrous ethanol, using sulphur or castor oil. Provided by F. Marc de Piolenc.

Absolute Alcohol Using Glycerine -- Mariller-Granger Processes, from E. Boullanger: Distillerie Agricole et Industrielle (Paris: Ballire, 1924). Mariller's absolute alcohol production process by dehydration using glycerine, various systems examined and explained. Translation from the French by F. Marc de Piolenc.

Hooch

Home Distillation of Alcohol (Homemade Alcohol)
http://www.homedistiller.org
Very informative and well-linked site by chemical engineer Tony Ackland, on distilling for the bottle rather than the fuel tank. Thorough treatment of the subject, great resources here, excellent site, recommended.

Distillation - How it works, by Mike Nixon -- all is explained, clear and simple guide. (Acrobat File)
http://www.webconx.dns2go.com/distill_howitworks.pdf
See **The Compleat Distiller** by Mike Nixon and Mike McCaw

The HOOCH page
http://www.beer.org/~tpark/hch.html
Good basic instructions, explanations, directions on how to distill alcohol -- beverage alcohol obviously, with a name like The HOOCH page.

Culture Corner Archive: **Makin' Moonshine**
http://www.manalagi.com/jamesplace/indonesia/sopi/index.html
Appropriate technology in East Indonesia: making moonshine (sopi) from lontar palm juice (nirah), using a steel oil drum, a wooden lid sealed with sticky lontar fruit, plus bamboo and copper tubing, and a cooler made from a hollowed-out lontar palm trunk.

Still in orbit
http://theshredder.com/archive/mir1.html

"According to an intercepted communication, the Mission Control has demanded that the cosmonauts aboard the Mir Space Station get rid of the liquor-brewing still illegally installed aboard by one of the previous crews. It is the presence of the still, maintains a program official who would not be identified, that forced the recent shutdown of the main computer." Believe it or not.

Cosmonauts Tsibliyev, Lazutkin: "... traces of alcohol".

The x86 still
http://www.exaflop.org/docs/x86still/
"To put it simply, the key components [of a still] are a heating device and a cooling device. Now the average PC has both a heating device (the processor) and a cooling device (the fan). The question we asked was 'By separating the processor from its fan and adding a few small components, could we convince an ordinary PC to distill alcohol?'"
Yes it could!
"I had needed to reboot the machine twice in that time (due to over heating) and decided to call it a day after Linux failed to restart (at the third reboot attempt)."
Maybe that's how they do it on Mir...

Ethanol and your car

How To Adapt Your Automobile Engine For Ethyl Alcohol Use -- Mother Earth Alcohol Fuel Manual. **Biofuels Library**

How To Modify Your Car To Run On Alcohol Fuel: "Guidelines for converting gasoline engines (With Specific Instructions for Air-Cooled Volkswagens)" by Roger Lippman, April 1982 -- Five-chapter online book:
http://terrasol.home.igc.org/alky/alky.htm

How to modify an injection system: It's Toyota-specific, but applies to most electronic fuel injection systems.
http://www.geocities.com/MotorCity/Pit/9975/dataBySubject/EFImods.html

Flexible Fuel Vehicles and E85

In the US, **E85** fuel is comprised of 85% ethanol by volume and just 15% petroleum. Though it hasn't received nearly as much publicity as it should have, many autos sold in the US are **"Flexible Fuel Vehicles"** (FFVs) that can run on E85 or gasoline when E85 is unavailable. More than 750,000 FFVs made their way to US showrooms in 2000. Ford, Daimler Chrysler, General Motors, Isuzu, Mazda, Mercury all make FFVs. The following websites have details of which models are FFVs.

American Lung Association
http://www.alamn.org/outdoor/e85.htm

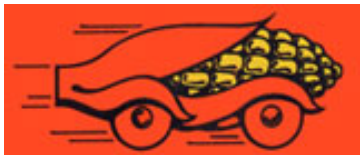
National Ethanol Vehicle Coalition
http://www.e85fuel.com/ffvs.htm

Alternative Fuels Data Center, US Dept of Energy
http://www.afdc.doe.gov/afvehicles.html

E85 summer blend is 85% ethanol 15% gasoline; E85 winter blend is 70% ethanol 30% gasoline.

How-to books

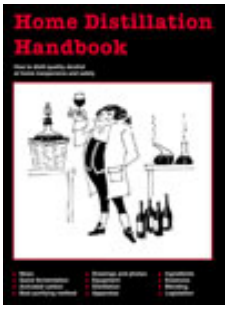
Alcohol Fuel Manual: "The Manual for the Home and Farm Production of Alcohol Fuel" by S.W. Mathewson, 1980, Ten Speed Press, out of print -- this excellent manual gives you all the information you need to get going with making your own alcohol fuel. Aimed at small-scale production, good chapters on fuel theory, everything about feedstocks, processing, fermentation, yeast, using ethanol, distillation. Go to the **Biofuels Library**.



Mother Earth Alcohol Fuel -- a guide to the fine points of home alcohol production, Mother's Alcohol Fuel Seminar, The Mother Earth News, 1980, out of print -- in 1978 The Mother Earth News research team started studying methods and distillation processes, testing mash formulas, designing apparatus, compiling information, converting engines and running seminars, spending upwards of US$300,000 on the project. This manual is the result. Go to the **Biofuels Library**.

"The Compleat Distiller" by Mike Nixon and Mike McCaw, The Amphora Society, 2001
It may sound like an over-ambitious title, but it's just an accurate description. It covers everything, it's clearly written, well-organised, a pleasure to read. The guys on the Distillers mailing list love it: "One great distilling book! I haven't ever read

a distilling book as complete as this. Everything is covered." Another: "If you ever have thought about buying just one book on distillation, this should be that book. If you are a beginner, this book is perfect. If you have been taught the art by your old pappy livin' in those there hills, this book is for you. If you are a master crafter and know everything, this book is for you." Order online, as a PDF (Acrobat file) or a printed book:
http://www.amphora-society.com



Home Distillation Handbook, by Ola Norrman (pseudonym)
http://partyman.se/HbBok/home_distilling_handbook.html
"It is possibly the best book that has ever been written on the subject," claims the home page modestly. "Worth it," says Ted Park of The HOOCH page. "Really good instructions." Also recommended by the Alt.Alcohol newsgroup's FAQ. US$17 for the book, $5 for the download version.

Building a Home Distillation Apparatus -- A Step by Step Guide, by Bob Lennon. Detailed online guide, focus on building and operating the StillMaker still: "does not enter into the domains of fermentation, recipes for making mash, beer, wine or any other spirits". Many homebrewers have built this still. Lennon says it "easily produces 95% ethanol in a single pass". Designed with the aid of computer programs which modeled continuously operating fractionating columns and the results were then adjusted to accommodate a batch processing operation. Now with two versions -- as well as the internal reflux model, Bob's added a new design for a reflux column with a top mounted condensor, using a beer keg as the boiler (the valved reflux model). Online and in Acrobat format, free.
http://www.Moonshine-Still.com

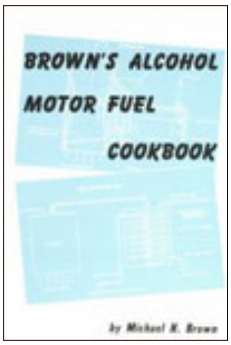
Secrets of Building an Alcohol Producing Still, by Vince Gingery
http://www.lindsaybks.com/dgjp/djgbk/still/index.html
"Great book!" says distributor Lindsay Publications. "Be independent. Thumb your nose at the corner gas station. Build a still, and make fuel." How to take common plumbing parts, copper sheeting, and standard electrical parts and build a 6 gallon capacity still. US$12.95.

Makin' It on the Farm -- Alcohol Fuel is the Road to Independence, by Micki Nellis
http://buffalo-creek-press.com/alcohol.htm
"This book is still in demand after 18 years. Referenced in many alternative energy guides, how-to books, and in the ATF's own guide to fuel alcohol. Was used as a textbook in several community colleges." Buffalo Creek Press US$2.95.

Moonshine Motorfuel -- Practical Fuel-Alcohol Handbook. How to make it, how to use it! by Tom Hamn
http://www.homemadeautofuel.com/saleltr.html
"Learn simple design concepts for distillation equipment ranging from the most rudimentary pot still to a 30 gallon-per-hour MONSTROSITY!" US$19.95 plus $4.87 S&H.

How to produce your own alcohol -- Training manual from Marc Carduso at Ecogenics. Marc is one of the original biofuellers -- he built a prize-winning backyard fuel still in the '70s. "One of the most comprehensive manuals on alcohol

production. Learn how to produce alcohol from organic wastes including cellulose from conventional crops. Learn how to convert your motors to run on low-proof alcohol." Also training seminars on alcohol fuel production. Lots more to see at this interesting site!
http://www.dabney.com/ecogenics/



Alcohol Motor Fuel Cookbook, by Mike Brown -- How to ferment grain into alcohol and modify carburetors to run on it. One of the originals, new edition now available. US$20.
http://home.earthlink.net/~dlaw70/alteng.htm#bamfc

Alcohol Distiller's Handbook, by Mike Brown -- covers milling, mashing, fermentation, distillation, distillers' dried grain and solubles and laboratory control. Perfect for personal fuel self-sufficiency or commercial production. $25
http://home.earthlink.net/~dlaw70/alteng.htm

How To Build A Junkyard Still, by Mike Brown -- be your own motor fuel magnate. $12.00.
http://home.earthlink.net/~dlaw70/alteng.htm#junkyard

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Is ethanol energy-efficient?

One of the most controversial issues relating to ethanol is the question of what environmentalists call the "net energy" of ethanol production. Simply put, is more energy used to grow and process the raw material into ethanol than is contained in the ethanol itself?

In the US most ethanol is made from corn (maize). A US Department of Agriculture study concludes that ethanol contains 34% more energy than is used to grow and harvest the corn and distill it into ethanol. "**Estimating the Net Energy Balance of Corn Ethanol**", by Hosein Shapouri et al., US Department of Agriculture, Economic Research Service, Office of Energy and New Uses, Agricultural Economic Report No. 721, July 1995 -- "Studies conducted since the late 1970s have estimated the net energy value of corn ethanol. However, variations in data and assumptions used among the studies have resulted in a wide range of estimates. This study identifies the factors causing this wide variation and develops a more consistent estimate... We show that corn ethanol is energy efficient as indicated by an energy ratio of 1.24."
http://www.ethanol-gec.org/corn_eth.htm

"**The Energy Balance of Corn Ethanol: An Update**", by Hosein Shapouri and James A. Duffield, U.S. Department of Agriculture, Office of Energy Policy and New Uses, and Michael Wang of the Center for Transportation Research, Energy Systems Division, Argonne National Laboratory. Agricultural Economic Report No. 813: "Corn ethanol is energy efficient... For every BTU dedicated to producing ethanol there is a 34% energy gain... Only about 17% of the energy used to produce ethanol comes from liquid fuels, such as gasoline and diesel fuel. For every 1 BTU of liquid fuel used to produce ethanol, there is a 6.34 BTU gain."
http://www.ethanolrfa.org/pr020801b.html
Full report (Acrobat file, 176 kb):
http://www.usda.gov/oce/oepnu/aer-814.pdf

In "**How Much Energy Does It Take to Make a Gallon of Ethanol?**", David Lorenz and David Morris of the Institute for Local-Self Reliance (ILSR) state: "Using the best farming and production methods, the amount of energy contained in a gallon of ethanol is more than twice the energy used to grow the corn and convert it to ethanol." A 1992 ILSR study, based on actual energy consumption data from farmers and ethanol plant operators, found that the production of ethanol from corn is a positive net energy generator. In this updated paper the numbers look even more attractive: more energy is contained in the ethanol and the other by-products of corn processing than is used to grow the corn and convert it into ethanol and by-products.

Straight vegetable oil as diesel fuel

Spanish-language sister-site for DIY biodieselers
EN ESPAÑOL, sitio hermano para biodieseleros DIY

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What works and fits

http://www.carbohydrateeconomy.org/ceic/library/admin/uploadedfiles/How_Much_Energy_Does_it_Take_to_Make_a_Gallon_.html

"Ethanol production is extremely energy efficient, with a positive energy balance of 125%, compared to 85% for gasoline. Ethanol production is by far the most efficient method of producing liquid transportation fuels. According to USDA, each BTU (British Thermal Unit, an energy measure) used to produce a BTU of gasoline could be used to produce 8 BTUs of ethanol." -- **American Coalition for Ethanol** (ACE): see "Energy / Trade Benefits": http://www.ethanol.org/Information/ethanol_information.htm

What standard farm?

In fact it's a very theoretical question. A "standard" farming procedure is a myth, and even if it wasn't, what would that have to do with a homesteader with a good supply of waste wood to burn and no better way of using it, and a large supply of past-their-use-by cakes from a bread factory that he's rescuing from the waste stream? (An actual case.) The cakes could go to a pig farm instead, but they don't. There are many such niches -- spoiled fruit from farms that ought to have pigs but don't, and so on and on. Such factors never get calculated.

And what would all that have to do with this? "We are looking at a very interesting integrated distillery approach being developed by the Brazilians, where instead of going for the large 300,000 litres per day plants, a fully integrated approach is taken with a 1,500 ha area, farmed by small growers, and feeding sugarcane and sweet sorghum into a 20,000 litres per day plant, with cattle feedlots at the distillery, the manure going into [biogas] digesters with the stillage, producing enough energy for the distillery, leaving the bulk of the bagasse to be used for power generation to supply the surrounding areas." (Energy projects in Africa.)

Once you start looking at the local level and at integrated approaches to crop production and wastes, and include energy production and use, a very different picture emerges that leaves these broad energy in/energy out generalisations without much meaning.

There's yet another way of looking at it. This is from **Offgrid-Online**, April 5, 2000.
http://www.offgridknowhow.com/
"Will we get out more energy than we put in? Does it matter? Generally a scheme that did not create more energy than it consumed would be useless, but in this case we might have a different view. Since we are after a *portable* fuel, we might be willing to spend more energy to get it, so long as we used a non-portable fuel to do so. For example, suppose we use wood-fired heat to make alcohol. Wood is a poor fuel as far as portability in general is concerned and is nearly useless for internal

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combustion engines. So what if we have to spend 2 BTUs of wood heat for each BTU of alcohol fuel produced? That might still be a good deal if we had lots of wood and gasoline was (that is, continues to be) highly priced."
http://www.homesteadtechnology.com/newsletters/20000405.txt

The **Sierra Club** in the US has a different objection to ethanol. They see the whole issue as clouded by the high levels of nitrogen fertilisers used to grow the maize, and the terrific eco-damage the N-runoff causes. But that's an objection to US factory farming, not to ethanol. In a more rational system there's no need for nitrogen fertilisers, and no loss of yield through not using them.

One 15-year study found that organic farming is not only kinder to the environment than "conventional", intensive agriculture but has comparable yields of both products and profits. The study showed that yields of organic maize are identical to yields of maize grown with fertilisers and pesticides, while soil quality in the organic fields dramatically improves. (Drinkwater, L.E., Wagoner, P. & Sarrantonio, M. Legume-based cropping systems have reduced carbon and nitrogen losses. Nature 396, 262–265.)

None of this considers the fact that ethanol is a much cleaner fuel than gasoline, reducing air-pollution, nor that it is a renewable fuel made from plants -- unlike fossil-fuels, manufacturing it and burning it does not increase the greenhouse effect.

It also has an important role in biodiesel production: ethyl esters biodiesel is cleaner and more rational than methyl esters biodiesel made with methanol, which, unlike ethanol, is toxic, derived from fossil fuels, and you can't make it yourself.

Ethanol under fire

In August 2001 Cornell University's Prof. David Pimentel attacked the economics of corn-to-ethanol production. In an article published in the Encyclopedia of Physical Sciences and Technology, Pimentel asserted that ethanol production is uneconomic: "The growers and processors can't afford to burn ethanol to make ethanol. US drivers couldn't afford it, either, if it weren't for government subsidies to artificially lower the price."

"Ethanol fuel from corn faulted as 'unsustainable subsidized food burning' in analysis by Cornell scientist", August 6, 2001 -- "Neither increases in government subsidies to corn-based ethanol fuel nor hikes in the price of petroleum can overcome what one Cornell University agricultural scientist calls a fundamental input-yield problem: It takes more energy to make ethanol from grain than the combustion of ethanol produces."

http://www.news.cornell.edu/releases/Aug01/corn-basedethanol.hrs.html

In a detailed analysis of Pimentel's research, Dr. Michael S. Graboski of the Colorado School of Mines says Pimentel's findings are based on out-of-date statistics and are contradicted by a recent US Department of Agriculture (USDA) study.

"Comparison of USDA and Pimentel Net Energy Balances" -- "The USDA analysis clearly shows, contrary to the Pimentel paper, that US farming and ethanol manufacture are very energy efficient, and that the energy content of ethanol delivered to the consumer is significantly larger than the total fossil energy inputs required to produce it. USDA estimates that ethanol facilities produce at least 1.23 units of energy as ethanol for every fossil BTU included considering all energy inputs related to corn farming, corn transport, ethanol production, and distribution and transport of finished ethanol." Full report: http://www.ncga.com/public_policy/issues/2001/ethanol/08_22_01b.htm

"Pimentel clearly does not understand the economics of ethanol manufacture" -- a full rebuttal, from the US National Corn Growers Association.
http://www.ncga.com/public_policy/issues/2001/ethanol/08_22_01a.htm

Another thorough rebuttal, by the Rooster News Network: **"Industry Argues That Ethanol Delivers"**

In fact this isn't the first time Pimentel has published misinformation about ethanol, nor the first time critics have poked his analyses full of holes, but that doesn't seem to stop him. In 1998 he published this report:

"Energy and Dollar Costs of Ethanol Production with Corn" by David Pimentel, April 1998 -- "Ethanol does not provide energy security for the future. It is not a renewable energy source, is costly in terms of production and subsidies, and its production causes serious environmental degradation."
http://hubbert.mines.edu/news/v98n2/mkh-new7.html

This report was debunked by, among others, Michael Wang and Dan Santini of the Center for Transportation Research, Argonne National Laboratory, who conducted a series of detailed analyses on energy and emission impacts of corn ethanol from 1997 through 1999:

"Corn-Based Ethanol Does Indeed Achieve Energy Benefits" -- "Prof. David Pimentel's 1998 assessment of corn ethanol concluded that corn ethanol achieved a negative energy balance (which is usually defined as the energy in a product minus energy used to produce the product). Unfortunately, his assessment lacked timeliness in that it relied on data appropriate to conditions of the 1970s and early 1980s, but

clearly not the 1990s... With up-to-date information on corn farming and ethanol production and treating ethanol co-products fairly, we have concluded that corn-based ethanol now has a positive energy balance of about 20,000 Btu per gallon."
http://www.ncga.com/public_policy/issues/2001/ethanol/08_22_01c.htm

Wang and Santini found that Pimentel has been recycling his ancient data for at least 10 years.

In August 2002 a new report from the USDA found that, not only is ethanol energy-efficient, but it's efficiency is steadily improving.

"Only Dr. Pimentel disagrees with this analysis. But his outdated work has been refuted by experts from entities as diverse as the USDA, DOE, Argonne National Laboratory, Michigan State University, and the Colorado School of Mines. While the opponents of ethanol will no doubt continue to peddle Pimentel's baseless charges, they are absolutely without credibility," the Renewable Fuels Association commented.

"**From stalk to fuel tank, ethanol a net energy gain**" --
Washington, August 7, 2002, Reuters: Measured from cornfield to the fuel tank, ethanol provides more energy than is consumed in producing it, researchers said in a new report that could figure in congressional debate over U.S. energy policy.
http://www.planetark.org/dailynewsstory.cfm/newsid/17186/story.htm
The Renewable Fuels Association report on the study:
http://www.ethanolrfa.org/pr020801b.html
Full report (Acrobat file, 176 kb):
http://www.usda.gov/oce/oepnu/aer-814.pdf

Under the heading "Food Versus Fuel Issues", Pimentel writes that "expanding ethanol production could entail diverting essential cropland from producing corn needed to sustain human life to producing corn for ethanol factories." He says corn is "a human-food resource" and adds: "Present food shortages throughout the world call attention to the importance of continuing US exports of corn and other grains for human food to reduce malnutrition and starvation. Increased corn exports... most importantly help feed people who need additional food for their survival."

But as Pimentel should surely know, most US corn is used for feeding animals, not hungry people -- 76% of the corn used in the US is used for animal feed. Twenty percent of the total US corn crop is exported; two-thirds of these exports go directly to the wealthy industrial OECD countries, mostly to feed animals.

Less than three-tenths of one percent of total US corn exports went to the 25 poorest countries in 1996. More US corn goes to make alcoholic beverages in the US than is exported to feed the hungry in the world's 25

most undernourished countries combined.

See **Food or Fuel?**

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Trees, soil and water

In the news

Floods Kill 80 in Nepal

KATHMANDU, Nepal, July 20, 1999 (ENS) -- Floods and landslides have killed at least 80 people in Nepal. Millions of dollars worth of property are lost. Forests on the Himalayan mountainsides used to absorb much of the annual summer monsoon rain, but widespread clearcutting has now allowed the water to reach unprecedented flood proportions. Fifty-five out of 75 districts of this Himalayan Kingdom have been badly affected by floods and landslides triggered by the heavy downpours. Several hundred houses, thousands of hectares of rice paddy fields and dozens of bridges have also been washed away.
http://ens.lycos.com/ens/jul99/1999L-07-20-02.html

Floods: BEIJING, August 26, 1998: At a government news conference on the disastrous floods Tuesday, Zhao Qizheng, chief of the State Council Information Office, said the government had decided to shut down logging activities in the upper catchments of the Yangtze River. The deforestation has led to more rapid runoff of rain waters and increased silting of river and lake beds. He said all cleared areas would be replanted in a long-term strategy of ecological restoration. (The New York Times)

One year later:

Drought Evaporates Water Supply for Hong Kong, Shenzhen, Canton

SHENZHEN, China, August 24, 1999 (ENS) -- At the same time that flood waters along the Yangtze River in central China have killed 800 and displaced millions this summer, the drying up of the East River in southern China's Guangdong Province has led to a serious water shortage problem in the Pearl River Delta.
http://ens.lycos.com/ens/aug99/1999L-08-24-01.html

Logging Blamed in Vietnam's Second Wave of Floods

HANOI, Vietnam, December 9, 1999 (ENS) -- Environmentalists are blaming widespread illegal logging as a factor in disastrous flooding that has hit the central coast of Vietnam for the second time in two months.
http://ens.lycos.com/ens/dec99/1999L-12-09-01.html

Erosion caused by deforestation sends a stain of sediment into the sea off the Mekong Delta in Vietnam (Photo courtesy National Aeronautic and Space Administration) -- ENS

Indonesia's Forests Vanishing Faster Than Ever

JAKARTA, January 25, 2000 -- Indonesia's forests are disappearing even faster than studies a few years ago indicated. Using 1997 satellite imagery, the Ministry of Forestry and Estate Crops has produced new forest

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cover maps for the islands of Kalimantan, Sulawesi and Sumatra which show a shocking loss of more than 17 million hectares in 12 years. This is one-fourth of the total Indonesian forest cover that existed in 1985. The ministry now estimates that the nationwide annual deforestation rate is at least 1.5 million hectares, nearly twice the estimate published by the World Bank in 1994. (International Herald Tribune)

Illegal Logging Rips Up Tanzanian Forests

DAR ES SALAAM, Tanzania, August 26, 1999 (ENS) -- Illegal exploitation of forests in Tanzania has reached a point of crisis. The illicit activities, some by government officials, place Tanzania's 33.5 million hectares (129,310 square miles) of forest and woodland increasingly at risk. An estimated 500,000 hectares (19,300 square miles) of Tanzania's pristine forests are lost annually through illegal timber trade.
http://ens.lycos.com/ens/aug99/1999L-08-26-04.html

Amazon hatchet job

Monday, June 21, 1999, Environmental News Network: The Brazilian government is planning to effectively gut efforts to protect the Amazon, despite news that the world's largest and most quickly disappearing rainforest is being cleared twice as quickly as previously thought. In response to the fiscal austerity measures imposed by the International Monetary Fund's $41 billion bailout package signed last November, Brazil is planning to zero out between 60 and 90% of its $70 million budget for conservation and environmental programs in the Amazon.
http://www.enn.com/enn-features-archive/1999/06/062199/amazon_3870.asp

Environmental degradation wears on Pakistan

December 5, 1999, Environmental News Network -- Stress on the environment and on forest cover in particular is amplifying social problems and creating both an ecological and human crisis in Pakistan's Northwest Frontier Province, according to a recent study.
http://www.enn.com/enn-news-archive/1999/12/120599/notrees_7836.asp

Rivers of the World Mismanaged, Polluted

WASHINGTON, DC, November 29, 1999 (ENS) -- More than half the world's major rivers are going dry or are polluted, the World Commission on Water for the 21st Century warned in a report released today in Washington.
http://ens.lycos.com/ens/nov99/1999L-11-29-03.html

Misuse, waste of water could lead to world-wide water crisis

August 7, 1995, Environmental News Network: The world must stop wasting and misusing water or face ever-sharper challenges to agriculture, industry and health in water-short regions, according to the World Bank. Some 80 nations holding 40% of the world's population now experience water shortages, according to the Bank.
http://www.enn.com/enn-news-archive/1995/08/080795/08079513.asp

Water experts call for Blue Revolution

ENN August 27, 1998 -- By the year 2025, 35% of the world's projected population of 8 billion people will face water shortages, according to a

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university report. The authors of the report, from Johns Hopkins University School of Public Health, concede, however, that "it may already be too late for some water-short countries with rapid population growth to avoid a crisis."
http://www.enn.com/enn-news-archive/1998/08/082798/water26.asp

Growing Population Faces Shrinking Water Supply
WASHINGTON, DC, July 20, 1999 (ENS) -- Increasing water shortages may lead to global hunger, civil unrest and even war, according to Sandra Postel, director of the Global Water Policy Project and senior fellow with the Worldwatch Institute. The number of people living in water stressed countries is projected to climb from 470 million to 3 billion by 2025, Postel notes. (See the reference.)
http://ens.lycos.com/ens/jul99/1999L-07-20-01.html

Poor pay more -- poor people in the developing world pay on average 12 times more per litre of water than the rich do and it's often contaminated, according to the World Commission on Water for the 21st Century. Poor people pay huge premiums to water vendors -- 60 times more in Jakarta, 83 times more in Karachi, 100 times more in Haiti and Mauritania. 1.2 billion people around the world lack access to safe water, and 3.4 million of them die each year from water-related diseases.
http://www.watervision.org/clients/wv/water.nsf/%28webNews%29/A9E2715BE702AEDCC12567C40030C25A

Monsanto (had) plan to cash in on world water crisis
INDEPENDENT (London) September 26, 1999: Monsanto, the genetically modified food giant, drew up plans to make billions of dollars out of the world's water crisis, confidential company documents reveal. The documents, seen by the Independent on Sunday, identify a "vast economic opportunity" for the company in impending global shortages of resources such as water. They outline a strategy to use "environmental issues" to "deliver strong financial returns". The business plan adds that two billion people worldwide "still lack reasonable access to safe water" and says that this is likely to rise to 2.5 billion over the next decade. "Initial entry into the water business will create US$400m in annual revenues". The plan foresees the potential to create several billion dollars in annual revenue. Monsanto recently dropped plans to establish water businesses in India and Mexico. A Monsanto spokesman confirmed that the company had made plans to exploit the world water situation but had decided several months ago not to proceed. He did not rule out that the company might return to them in the future.

"Monsanto and water privatization", THE HINDU, Saturday, May 1, 1999, by Vandana Shiva: Over the past few years, Monsanto, a chemical firm, has positioned itself as an agricultural company through control over seed -- the first link in the food chain. Monsanto now wants to control water, the very basis of life. "What you are seeing is not just a consolidation of seed companies, it's really a consolidation of the entire food chain. Since water is as central to food production as seed is, and without water life is not possible, Monsanto is now trying to establish its control over water," said Robert Farley of Monsanto. "Monsanto plans to launch a new water

business, starting with India and Mexico since both these countries are facing water shortages." Privatization and commodification of water are a threat to the right to life. Water is a commons and must be managed as a commons. It cannot be controlled and sold by a life sciences corporation that peddles in death.
http://www.portaec.net/library/food/waterwatch.html

-- The average 15,000 cubic metres of water needed to irrigate one hectare of high-yielding modern rice is enough for 100 nomads and 450 cattle for three years, or 100 rural families for three years, or 100 urban families for two years. The same amount can supply 100 luxury hotel guests for just 55 days. (UN Food and Agriculture Organization -- FAO.)

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Trees for the Future

Trees for the Future promotes reforestation and environmentally sustainable land use, in cooperation with local groups and individuals in their own communities around the world. Seeds and guidelines provide people around the world an opportunity to benefit from improved crop yields, erosion control and protection of their water supply. In return, these people do the work. "Since 1989, we have started more than 5,200 village projects in more than 60 countries in Africa, Asia and Latin America." Also anti-global warming programs like "Cool Cars", which plants 200 trees per certificate, enough to counteract the CO2 produced by one car in one year, and "Tree Pals" for kids.
http://www.treesftf.org/

The Chipko movement

This is the Chipko slogan: "What do the forests bear? Soil, water and pure air!" Exactly right!A quarter of a century ago a group of women in the Reni forests of Garhwal Himalaya in India succeeded in chasing away timber felling contractors -- by hugging the trees. This event became a milestone in the evolution of the now-famous Chipko movement, which spread to many threatened areas of the Himalayas. It was also a milestone in the evolution of People Power. But now Chipko's gains are once again under threat from commercial logging interests.

Chipko Movement, India -- a summary of the movement and its significance.
http://iisd.net/50comm/commdb/desc/d07.htm

"Chipko Movement: Of Floated Myths and Flouted Realities" by Jayanta Bandyopadhyay takes a fresh look at the famous Chipko Movement, its origins and development, and its true setting.
http://www2.mtnforum.org/mtnforum/archives/reportspubs/library/bandj99a.htm

"Hug the Trees!" -- long article by Mark Shepard on Chandi Prasad Bhatt and the Chipko Movement. Many people have the wrong idea about the Chipko movement.

Chandi Prasad Bhatt

"The main goal of our movement is not *saving* trees, but the *judicious use* of trees," says Chandi Prasad Bhatt, one of the founders of the movement. Long after the end of colonialism, the mountain people were still being exploited and their forests ruined by tree felling companies from the plains supported by the Forest Department of the Indian government. Increasingly threatened by poverty and floods, the mountain villagers took action to protect their livelihood, demanding that the resources of the mountain forests should benefit the mountain communities, providing work and the means of survival. Their struggle won them an active role in the management of their forests. "We respect the needs of people in the plains for the products of our forests," Chandi Prasad says -- but Chipko believes that their needs too are better

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met if the forests are managed by those who live in them. An excellent article.
http://www.markshep.com/nonviolence/GT_Chipko.html

Eroding the Gains from Forest Protection -- NEW DELHI, Jan 25 (InterPress Service): Himalayan forests which have been protected from loggers by village communities and government restrictions have now been opened to commercial logging in one northern Indian state.
http://www.link.no/IPS/art/eng/serv/AP/2000/01/25/15.41_062.html
(Subscribers only)

Opportunities to save and sustainably use the world's forests

The world's forests continue to deteriorate despite international efforts to save them. Deforestation rates in tropical countries are increasing, sustainable forest management is rare, mature forests are being replaced by even-aged, highly simplified stands. International accords are of limited use. But there are promising avenues for international action, some of the most important of which are being stimulated, nurtured, and implemented by non-governmental institutions, including private business interests. Includes six case studies of local initiatives. Thorough treatment by author Nigel Sizer -- long, but worth it.
http://www.iisd.ca/linkages/forestry/sizer.html

Respectful Forestry

Forest ecosystems could serve us generously if we would work with them, says Robert Brothers of the Context Institute in this thoughtful paper. "The possibility that we could have both timber products and a beautiful forest is rarely considered, perhaps because it is rarely exemplified. Yet the simple truth is that lumber for houses can be taken from the forest on a sustainable basis only if the beauty, health, and integrity of the total forest ecosystem (herbs, birds, bugs, and bears) is also sustained. Sustainable forestry works. It is being practised successfully -- in both economic and ecological terms -- by people sprinkled across the continent and around the world."
http://www.context.org/ICLIB/IC08/Brothers.htm

World Rainforest Movement

The World Rainforest Movement is a global network of citizens' groups of North and South involved in efforts to defend the world's rainforests against the forces that destroy them. It works to secure the lands and livelihoods of forest peoples and supports their efforts to defend the forests from commercial logging, dams, mining, plantations, shrimp farms, colonization and settlement and other projects that threaten them. Information, bulletin, worldwide action alerts, links.
http://www.wrm.org.uy/

The World Rainforest Movement's "**Penang Declaration**" identifies the main causes of tropical deforestation and the deficiencies of the main official responses to the deforestation crisis, and proposes an alternative model of "development" in the rainforests based on securing the lands and livelihoods of forest peoples.
http://www.wrm.org.uy/english/declarations/penang.htm

Rainforest Foundation

The Rainforest Foundation is an international network with projects in 18 rainforest countries throughout Asia, Africa, Central and South America. It was

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founded following demands by Raoni, a Menkragnoti Kayapó chief who sought help to protect his people's homelands in the Amazon Rainforest. In 1993, the Rainforest Foundation fulfilled its promise to Chief Raoni: the legal demarcation of the territory was the first privately funded demarcation to be officially recognized in the history of the Brazil.
http://www.savetherest.org/home.html

Rainforest Information Centre is a volunteer, non-profit organization dedicated to protecting rainforests. Rainforest news, information and action alerts, the World Rainforest Report, forest projects, ethical building materials, deep ecology, educational projects and children's links, discussion group, the Good Wood Guide and more:
http://www.rainforestinfo.org.au/

Penan children in Sarawak

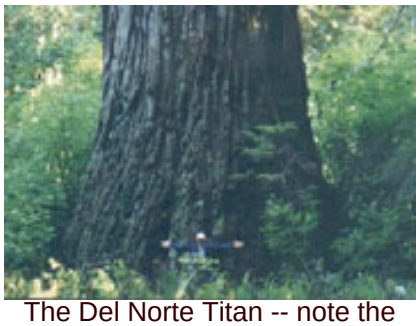
Vast rainforest, forest and biodiversity conservation news and information resources at **Gaia's Forest Conservation Archives**. Site search, Archives search, and search the best sites on the Internet through Gaia's Forest Conservation Portal:
http://forests.org/

Trees For Africa is a non-government, non-profit organization that assists community based organizations with greening projects. They donate trees to schools and other community groups anywhere in southern Africa, help communities to set up nurseries for plant supply, help develop permaculture food gardens, run environmental education, greening and permaculture workshops, and publish environmental education material and newsletters: Permaculture Villager, and Small Farm Forestry. Alas, no site search, yet.
http://www.junex.co.za/tfa/

The Jatropha System: "An Integrated Approach to Rural Development in Tropical & Subtropical Countries" -- use of the *Jatropha curcas* tree for erosion control, for enabling women, rural income generation, renewable energy production. Very nice project!
http://www.jatropha.org/

The **New Forests Project** is a people-to-people, direct-action program established in 1982 to initiate reforestation and reduce deforestation in developing countries. It has worked with more than 4,400 communities in over 120 countries, providing farmers, community organizations and environmental groups with what they need to begin successful reforestation projects. "We are helping to plant over 2,000,000 high-quality multi-purpose trees annually." Publishes New Forests News (occasionally!), back issues online. Website also features Tree Species of the Month and Tree-Education.
http://www.newforestsproject.com/

The Tall Trees Club recently discovered the **Del Norte Titan** -- not quite the


The Del Norte Titan -- note the person at the base of the tree

tallest tree in the world, but the largest, with a staggering volume estimated at 36,622 cubic feet of wood, or 440,000 board feet! These wonderful trees are the coast redwoods (Sequoia sempervirens) of California. The Titan is in the Jedediah Smith Redwoods State Park and it's 307' tall -- 93.5 metres. Tallest tree in the world is the Mendocino Tree in the Montgomery Woods, height 367.5 feet.
http://www.botanical.com/botanical/article/talltree

Read it and weep

The most ancient living things on earth are the Bristlecone Pines of California's forbidding White-Inyo mountains. The trees growing in the most extreme conditions, with scant soil and moisture, are the oldest, and oldest of all is the tree named "Methuselah", 4,723 years old and the world's oldest known living tree. But there was one older. Late in 1964 Donald R. Currey, a student at the University of North Carolina, who was working toward his doctorate, was searching for evidence of Ice Age glaciers and came upon the bristlecones near the Wheeler Peak glacier. He began to take core samples from several trees, discovering one to be over 4,000 years old! He asked for and was granted permission by the US Forest Service to cut the tree down. After cutting the trunk, 4,844 rings were counted. This student had just killed the oldest living thing on earth! Eventually, dendrochronologists determined the tree to be 4,950 years old.

http://www.sonic.net/bristlecone/

Get to grips with trees

Treeclimbing.COM -- Everything in the World about Tree Climbing, by Tree Climbers International: Recreational tree climbing, tree care, tree gear, chat room, Free Online Newsletter, cat rescue... it's all here.
http://www.treeclimbing.com/

WaterAid is the UK's specialist development charity working through partner organizations to help poor people in developing countries achieve sustainable improvements in their quality of life by improved domestic water supply, sanitation and associated hygiene practises. WaterAid works in 13 countries in Africa and Asia to improve the quality of life through lasting improvements to water, sanitation and hygiene using local skills and practical technologies. It estimates that projects completed have helped more than five and a half million people to gain access to improved water supplies and/or sanitation. Resources and information, focus on women and children.
http://www.wateraid.org.uk/

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Half the inhabitants of Earth cook over woodfires: nearly half the world's wood supply is used as fuel. But there's not enough of it to go round -- more than 2 billion people now face shortages of fuelwood. See **Solar box cookers**

The Henry Doubleday Research Association has assisted hundreds of projects in Third World countries, helping to plant millions of drought-resistant trees -- at a cost of less than a penny a tree. See **Trees for deserts**

"The Rape of the Earth: A World Survey of Soil Erosion", by G.V. Jacks and R.O. Whyte, Faber and Faber, London, 1939.
Don't say we weren't warned. If only we'd listened! "Erosion in Nature is a beneficent process without which the world would have died long ago. The same process, accelerated by human mismanagement, has become one of the most vicious and destructive forces that have ever been released by man." Not just a damnation, it also charts the path to redemption. As relevant today as when it was written. An extraordinary book.

"Tree Crops -- A Permanent Agriculture," by J. Russell Smith, Harcourt-Brace, New York, 1929; Devin-Adair, Connecticut, 1950; Island Press Conservation Classics, 1987, ISBN 0-933289-44-0
Russell Smith was 50 years ahead of his time, writing the basic text on agroforestry long before there was such a thing. He travelled widely and saw it all coming. The best book about trees -- it's inspired generations of environmental activists, including all the leading lights in the movement. Wonderful! Introductory chapters online in the **Small Farms Library**. Buy the book from Island Press:
http://www.islandpress.org/books/Detail.tpl?cart=30831123971221&SKU=0-933280-44-0

"Small Is Beautiful: Economics As If People Mattered", by E. F. Schumacher, HarperCollins, $14.00, ISBN 0060916303
This book has sold 700,000 copies -- no small

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figure for a book on economics. Required reading for anyone interested in development. If it had sold 7 million copies there'd probably be a lot less poverty, hunger and environmental degradation in the world than there is now.
Schumacher Society:
http://www.schumachersociety.org/
Intermediate Technology Development Group, founded by Schumacher in 1966:
http://www.itdg.org/home.html

"Pillar of Sand: Can the Irrigation Miracle Last?" by Sandra Postel, W.W. Norton & Company, 1999, $13.95, ISBN: 0393319377
Protecting rivers and vital ecosystems as the world aims to feed 8 billion people will require a doubling of water productivity -- getting twice as much benefit from each gallon removed from rivers, lakes, and aquifers. Pillar of Sand points the way toward managing the growing competition for scarce water. And it lays out a strategy for correcting the major flaw of the modern irrigation age: its failure to better the lives of the majority of the world's poorest farmers.
From Worldwatch Institute
http://www.worldwatch.org/pubs/ea/pos.html

"Gardening Without Irrigation -- or not much, anyway", by Steve Solomon, Seattle, Sasquatch Books, 1993. Originally published as *Waterwise Gardening*. Four color pictures. Full text online:
http://www.soilandhealth.org/

This is a guide to growing food without dependence on irrigation. Written from practical experience in western Oregon, which has a guaranteed four months of drought every year. It has broad applications to anyplace where the rains can't be depended upon.

Organic gardener Steve Solomon's dry garden

"Appropriate Farm Technologies for Cold and Dry Zones of the Hindu Kush-Himalayas", edited by Shaheena Hafeez, International

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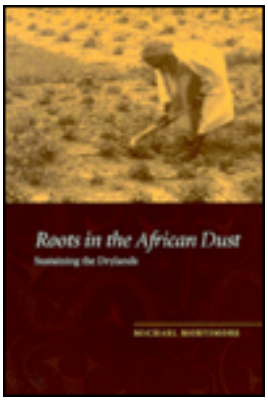
Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal, 1998. 153 pages. ISBN: 92-9115-838-0
Developed countries US$20.00, developing countries US$15.00; ICIMOD regional member countries US$10.00.
From ICIMOD, P.O. Box 3226, Kathmandu, Nepal
Fax: +977 (1) 524509, 536747
Email: distri@icimod.org.np
Over 1,000 tribes live in the highest, most fragile and most populous mountain regions in the world: the Hindu Kush-Himalayan Region (Afghanistan, Bhutan, India, Nepal, Bangladesh, China, Myanmar, and Pakistan). ICIMOD helps to "promote the development of an economically and environmentally sound mountain ecosystem and to improve the living standards of the mountain populations". This book focuses on "appropriate and indigenous farm technologies in selected sites within their respective countries". One chapter focuses on pro-women technologies: "Indigenous agro-based technologies are women-specific and focus on gender-equity in the male-dominated social structures of the HKH region by strengthening the economic empowerment of women." Order online:
http://www.icimod.org.sg/publications/catalogue/mfscatal.htm

"Roots in the African Dust: Sustaining the Sub-Saharan Drylands", by Michael Mortimore, Cambridge University Press, Cambridge, United Kingdom, 1998. 219 pages. ISBN: 0 521 45173 6 (hardback); ISBN: 0 521 45785 8 (paperback) US$59.95 (hardback)



The image of Africa in the modern world is shaped by perceptions of drylands and poverty, drought, degradation and famine. Mortimore offers an alternative vision, dismissing the conventional view of runaway desertification, driven by population growth and inappropriate land use. He suggests a more optimistic model of sustainable land use which is based on researched case studies from East and West Africa, where indigenous technological adaptation has put population growth and market opportunities to advantage. Order online:
http://www.cup.cam.ac.uk/

"The Simple Act Of Planting A Tree: A Citizen Forester's Guide to Healing Your Neighborhood, Your City, and Your World" TreePeople with Andy and

Katie Lipkis, Jeremy P. Tarcher, Inc., Los Angeles, 1990, $12.95, ISBN 0-87477-602-3 (paper).
This comprehensive training manual written and used by the urban forestry group Treepeople can be applied far beyond the California territory Treepeople now covers. Much of the information can be used in either tropical or temperate zones. The step-by-step Planting Project Workbook and the Tree Care Project Workbook contain specific notes that guide you through your project. "This book is dedicated to Citizen Foresters everywhere. May we reforest the earth!"
From TreeLink, the community forestry resource:
http://treelink.org/books/simpleact/index.htm
Also: What Tree Is That? -- an online guide to the more common trees found in the Eastern and Central US, courtesy of The National Arbor Day Foundation. Useful guide, step-by-step, yes-or-no, with illustrations.
http://treelink.org/whattree/

"Forest Farming: Towards a solution to problems of world hunger and conservation" by J. Sholto Douglas & Robert de J. Hart, Rodale Press, 1978, Intermediate Technology Publications, 1984, ISBN 0946688303
The integration of tree and other farming establishes a sounder ecological balance and greater productivity of food and materials for clothing, fuel and shelter. Only 8-10% of the world's surface is currently used for food production, but planting of crop-yielding trees could raise that figure to 75%. The book suggests planting and cropping methods and a range of potentially useful trees. Foreword by Fritz Schumacher ("Small is Beautiful"). From ECHO's global bookstore:
http://echonet.org/shopsite_sc/store/html/product42.html

New Crop Resource -- the Center for New Crops & Plant Products, at Purdue University, a vast database -- or group of databases -- of information on plants and trees both new and old. CropSEARCH, CropINDEX, CropREFERENCE -- Books and manuals; also Aromatic-MedicinalPLANTS, Famine Foods -- unconventional food sources, links.
http://www.hort.purdue.edu/newcrop/

Paper facts

A Paperless Office? Reams Pile Up Despite Computers

Wall Street Journal, May 28, 1999: When it comes to one of high tech's earliest promises -- to shrink the amount of paper weighing us down -- the industry gets a flunking grade. Each year, businesses world-wide use 4% to 7% MORE paper -- a pace that puts them on track to almost double their consumption each decade. And computing applications are clearly to blame. Introduce email to an office and the amount of printing soars 40%, according to one study.

Paper Facts, from Rethink Paper -- highly recommended website. Vision, information, action.
http://www.rethinkpaper.org/

- What is the global per capita consumption of paper? -- 108 lbs.
- How many newspapers do Americans buy a day? -- 62 million
- How many tons of professional printing and writing papers are produced annually in the US? -- 26.6 million tons
- What sector of the paper market is growing the fastest? -- Professional production and communication papers, having increased over 4 million tons in total volume between 1991 and 1997.
- How much paper does the United States consume per capita in one year? -- 735 lbs/person
- How many sheets of paper does the average person use in one year? -- 200,000 sheets
- By what percentage is global pulp and paper consumption projected to increase? -- According to the FAO by 100% by 2010
- How many sheets of paper are in one pound? -- 300 sheets
- Total amount of total wood pulp consumed in the US per ton/year? -- 64.1 million tons
- What is the average pulp and paper industry consumption of wood per year? -- 9.1 billion cubic feet
- What percentage of the original forests are remaining in the US? -- 5%
- What percentage of original global forests are remaining? -- 54%

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Trees for deserts

Overseas Projects
Henry Doubleday Research Association -- Britain's National Organic Gardening Association, Annual Report 1990

The HDRA has assisted hundreds of projects in Third World countries, helping to plant millions of drought-resistant trees -- at a cost of less than a penny a tree.

The continuing succession of famines in drought-stricken Africa seem the act of a vengeful God. Millions of people are at risk. Global appeals fight to get food to the emaciated hordes that pour out of the devastated lands and onto the world's television screens. No-one knows how many lives have been lost. Some campaigns have promised to end famines once and for all -- until the next mass tragedy unfolds. The problem seems intractable.

It is certainly complex, with no quick-fix solutions. It is also a truly ancient problem, and we should have seen it coming. In fact we did: "Destruction of the earth's thin living cover is proceeding at a rate and on a scale unparalleled in history, and when that thin cover -- the soil -- is gone, the fertile regions where it formerly lay will be uninhabitable deserts," wrote Jacks and Whyte more than 60 years ago in *The Rape of the Earth: A World Survey of Soil Erosion*. They continued: "The threat of a succession of man-made deserts is a very real one to all parts of Africa."

Today, the deserts are spreading at the rate of five million hectares a year worldwide (not yet quite as fast as the rainforests are vanishing), with a third of the world's land surface at risk from desertification -- an area larger than the whole continent of Africa.

'After the man the desert'

A potent mixture of economic pressures, modern agricultural practises and population growth have forced Third World farmers to fell tree cover to grow grains, forced farms into marginal areas and up steep slopes, forced herders into ever-smaller grazing areas. The last trees fall to the desperate need for firewood. The soil washes away with the rain, and neither are seen again. Crop-failure, famine.

The American researcher J. Russell Smith charted the process in

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Healthcare for mountains
Seeds of the world
No seeds, no food
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School and youth programs on the Web

four words: "Forest -- field -- plough -- desert". He also charted how this disastrous progression could be reversed, by using special trees. "When we develop an agriculture that fits the land, it will become an almost endless vista of green, crop-yielding trees," he wrote.

> **"The world needs experiment stations whose staffs are experts in the breeding of drought-resisting trees." -- J. Russell Smith (Tree Crops -- A Permanent Agriculture, 1929)**

That agriculture must "fit the land" is a basic organic concept. The conviction that encroaching deserts can be pushed back is at the heart of the HDRA's overseas work.

In 1986, in the wake of the Ethiopian famine, the HDRA set up the Drought Defeaters Project to investigate long-term solutions to some of the problems of drought and desertification. It was obvious that grain was needed in the short term, but that the people would never be able to feed themselves until the trend of tree-felling and soil loss could be reversed.

Desert trees

The project developed out of an interest in the extraordinary capacity of some trees to tolerate arid conditions. *Prosopis* trees, for instance, live in deserts.

They need almost no water, they grow rapidly and soon yield crops of firewood, they provide excellent forage for livestock, and they can be used to stop soil erosion. The HDRA had funded laboratory and greenhouse studies of such trees at three British universities, which had confirmed the drought tolerance of many potentially useful tree species.

Prosopis tree

We now planned to expand this work into a practical international program. Dr Phil Harris was seconded from Coventry Polytechnic to work at Ryton as the HDRA's Third World Projects Co-ordinator. The strategy followed the basic organic principles we advocate in the UK: it included work on conserving and collecting multipurpose trees and shrubs from arid areas;

Education resources on the Web
Children's poetry

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Japan

selecting and propagating the best species and varieties; testing trees and shrubs in sustainable forestry and agroforestry systems in tropical countries; and distributing tree seeds and growing techniques through an international network of development groups.

By 1989 the work had progressed to the point where we could offer practical assistance -- information and advice on selecting tree species for particular locations and purposes, details of recommended cultural practises,

Prosopis pods and leaves

and high-quality seed, tested by the HDRA, in sufficient quantity for practical introduction trials, free of charge, by return of post. These seeds are obtained from commercial suppliers or from collections made by the HDRA and overseas collaborators. Such a package can be of inestimable value to a struggling community.

We publicized this service in the leading development and agriculture journals. This brought a tremendous response from the developing world. In 1990 we were taking on two new projects a week.

Since the Tree Seed Distribution Project began in July 1989, we have provided information and advice to 194 projects in 38 African countries and have sent seed of 106 different selected tree species to 110 of these projects -- enough to plant 3,281,952 trees.

Seed for well over a million trees has been provided for agroforestry projects in the Ethiopian Highlands, with excellent results. This has all been achieved at a total cost of £28,038.04 -- less than a penny a tree. We have also assisted 30 projects in Asia, the Pacific and Latin America.

We work with key projects from which the benefits rapidly spread to local subsistence farmers. Of the projects we support, 30% are government extension projects, 47% are run by Non-Government Organizations (both local and international), and the remaining 23% are small projects or single farmers.

Our Overseas Projects staff has swelled from one to nine. Dr Harris's assistants at Ryton are Stephanie Woods and Marianne Sandison.

Coventry Polytechnic, Durham University, Wye College, Imperial

College and Kew Gardens have all contributed to the scientific work, and the HDRA also carries out collaborative research projects in the Republic of Cape Verde, the Sultanate of Oman, India, China and Australia.

Cape Verde

Although it is a group of islands in the Atlantic Ocean, Cape Verde is in the sub-Saharan climatic zone and suffers the same conditions. There hasn't really been a rainy season for decades.

Prosopis seedlings in Cape Verde -- Third World women are the main beneficiaries (HDRA Library)

The land is denuded and the soil long gone. Reafforestation is a national priority, and has concentrated on *Prosopis* trees. In 1986 the HDRA began a research collaboration with the Cape Verde National Agricultural Institute (INIA) which continues today. The HDRA has planted some 20,000 test trees and seeds of selected species have been provided for practical programs which have planted millions of trees on the islands, including species which are succeeding in problem areas.

The HDRA's Dr Claire Winsch left Cape Verde in 1990 after two years and was replaced by Frances Harris.

Spain

The closest truly arid conditions to Britain are to be found in Spain, where the HDRA is collaborating in a tree research program with a research centre set in the foothills of the Sierra Nevada. Hundreds of trees have been planted out and promising species selected for further trials, along with new species, including local trees.

Oman

The HDRA is working with Durham University on projects to conserve and investigate woodlands in the Wahiba Sands Desert of Oman, where communities of *Prosopis cineraria* and *Acacia tortilis* trees survive with little or no rainfall. This species of *Prosopis* yields useful timber and excellent firewood, the leaves make nutritious fodder for livestock, the pods are good fodder and also serve as a vegetable for humans, the flowers support honey production, and the bark can be used in leather tanning and yields an edible gum -- all on less then 75mm of rain and an eight-month

dry season. In 1990 the HDRA started working with Sultan Qaboos University in evaluating local drought-resistant tree species in some of the driest areas available.

India

The HDRA supports projects in India, Sri Lanka and Nepal, and in 1990 we began collaborating with two universities in North West India in investigating drought-resistant trees in the Thar Desert, mainly *Prosopis cineraria*.

"*Cineraria* is one of the few Old World species of Prosopis," says Dr. Phil Harris. "In Rajasthan and Pakistan, it has been the mainstay of the local economies for thousands of years. This is one of the great traditional agroforestry systems of the world. The people totally rely on the *Prosopis* tree: they lop it for fodder, they eat the pods, they interplant other crops with it. It tolerates incredibly dry conditions. However, very little has been done to conserve it, and it is threatened by over-population. There is tremendous scope to conserve, investigate and improve the tree, and to extend its use."

HDRA researchers have travelled throughout the range of *Prosopis cineraria* in India, often travelling by camel or donkey. "They have collected 33 of the most widely different types of this species, so we now have a wide range of germ plasm," says Dr Harris. "These will now be grown out in the Haryana region, a desert area, where we can study the better kinds.

"We're also feeding this material to the Cape Verde and Oman projects. The Haryana trials will be duplicated in Oman, and some of the best successions from Oman will then go to India. We expect to end up with a hundred or more radically different collections of the same species in cultivation."

Neem tree in India

Further work in India involves investigating why the Rajasthan teak, *Tecomella undulata*, a useful and beautiful desert tree, is not more widely spread than it is, and the secret of the apparent symbiosis found between *Prosopis* and neem trees on the desert fringes, where they grow together like one composite tree, their trunks touching, their leaves forming a common canopy.

China

In 1988 the HDRA began a collaborative laboratory and field research project with Shandong Teachers University in China on revegetation of an area of some 7,000 square kilometres in the Yellow River Delta, where the problem is not only desert conditions but saline soils. The project involves exchanges of English and Chinese researchers. Work is progressing well, with interplanting of amaranthus grain and other crops and trees. This work is relevant to other arid areas in temperate regions.

Australia

The HDRA is now collaborating with the University of Western Australia, which has been doing similar work with drought-resistant Australian species.

The future

HDRA Overseas Projects has been strongly supported by HDRA members -- regular donors who have stood by us from the very early days. The Drought Defeaters Project has also been funded by Comic Relief, Men of the Trees and the Overseas Development Administration (ODA). A large grant from the Forestry Research Program of the ODA will support the work in Oman and Cape Verde from 1991. The three-year collaboration with Shandong Teachers University in China has been extended to 1994.

Organic growing in the tropics

The HDRA's work with desert trees is to be extended with a new project to develop organic cropping systems in tropical agriculture.

"We have long felt that our work in agroforestry projects in developing countries is but one aspect of the organic philosophy," says HDRA Director Jackie Gear. "Organic principles apply universally, from amateur gardening and agriculture in the 'developed' countries through to food production in developing countries. We do not want to see these countries suffering the disastrous consequences of high-input agriculture. They should choose the organic way as the only truly sustainable system.

"Our thinking on this has been confirmed by the hundreds of enquiries we've received from developing countries thirsty for knowledge of organic systems. They cannot afford the high-tech approach, and they know that it causes worse problems than it solves.

"We applied to Comic Relief for a grant to develop organic agricultural cropping systems in developing countries, and we are very happy to report that we have been awarded £48,000 -- half the total funding required. We can now set the project in motion."

-- Written by Keith Addison

References

"The Rape of the Earth: A World Survey of Soil Erosion", by G.V. Jacks and R.O Whyte, Faber and Faber, London, 1939.

"Tree Crops -- A Permanent Agriculture," by J. Russell Smith, Harcourt-Brace, New York, 1929; Devin-Adair, Connecticut, 1950; Island Press Conservation Classics, 1987, ISBN 0-933289-44-0

Neem leaves and fruit

"***Prosopis cineraria*** -- A Multipurpose Tree for Arid Areas" by M.S. Sandison and P.J.C. Harris, Henry Doubleday Research Association, Ryton-on-Dunsmore, Coventry CV8 3LG, United Kingdom, with contributions from I. Hussain, Rajasthan Agricultural University, Udaipur 313 001, Rajasthan, India, and Nitrogen Fixing Tree Association (NFTA) staff. A publication of the Forest, Farm, and Community Tree Network (FACT Net). http://www.winrock.org/forestry/factpub/FACTSH/P_cineraria.html

HDRA -- the organic association
http://www.hdra.org.uk

How-to guides and Factsheets on organic gardening, composting, pest control -- including "What to do in the garden now" and advice by email. http://www.hdra.org.uk/gyo_how.htm

The HDRA's Schools Organic Network, launched in January 2000, to introduce children to the pleasures of sowing, planting, growing, nurturing and eventually harvesting the food to eat, using organic methods. Practical help for schools, with everything related to the curriculum. "Today's children could be forgiven for thinking that bananas come from boxes, peas come frozen in packets, and tomatoes from tins. The real origin of these foods -- that they come from living plants which grow in the soil -- is not apparent." http://www.hdra.org.uk/schools_organic_network/index.htm

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See also **Trees, soil and water**
Farming with trees

Rainforest Information Centre's Children's Rainforest information page - basic FAQ on forest issues gives children all the information they want. Site has huge resources to back up further inquiry. What are rainforests? Why are rainforests important? Why are the rainforests being destroyed? How can rainforests be saved? Good Children's Forest links page. Covers Temperate, Sub-tropical and Tropical rainforests.
http://forests.org/ric/children/edsup.htm

Apashira -- painted by David Esquival Amaringo, student, Peru

The **Rainforest Alliance** site is a good starting point to find resources on rainforest stories, activities, coloring books. Good resources for teachers and for kids. Allies in the Rainforest -- what students and schools can do to help stop the destruction of tropical forests.
http://www.rainforest-alliance.org/kids&teachers/index.html

Help Save the Rainforests -- links to lots of forest sites for kids, arranged as a Treasure Hunt linked to questions about why rainforests are important to everyone.
http://www.richmond.edu/~ed344/hunts/rainforest.html

Global Response organizes international letter writing campaigns to help local communities prevent many kinds of environmental destruction. Action Bulletins for students and teachers, K-8 grades, free Teachers' Packets.
http://www.globalresponse.org/

"We U'wa people are willing to give our lives to defend Mother Earth from this project [Occidental Petroleum] which will annihilate our culture, destroy nature and upset the world's balance." (Global Response)

Amazon Interactive -- games and interactive site about Ecuadorian rainforest. For adults too. Try running a community-based ecotourism project or try your hand at farming.
http://www.eduweb.com/amazon.html

Animals of the Rainforest by

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Midlakes Middle School -- brief introduction on rainforests and the threats to them and great information on threatened rainforest animals grouped in classes: amphibians, birds, fish, insects, mammals and reptiles. Good links to other animal pages and great pictures. Theme: "Extinction Is Forever".
http://www.animalsoftherainforest.org/

TreEducation from **New Forests Project** -- dedicated to teaching more about trees, forests and their environment. Types of Forests -- What is mangrove? Ecology and Trees -- Why is groundwater important? Agroforestry -- What is Multi-Cropping? Nitrogen Fixation and Legumes -- What are Rhizobia? Solar Box Cookers -- What they are and how can I make my own? (See **Solar box cookers for schools**.) Free packages for teachers and students, information about the New Forests Project, a copy of Seedling News, tree fact sheets, tree seeds, planting instructions and other information about how to start your own chapter of the New Forests Seedling Club. Excellent resources, high-quality material.
http://www.newforestsproject.com/teacher.html

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Appropriate technology

Appropriate technology resources
Agriculture resources
Wood resources
Blacksmithing
Wood fires that fit
Houses that fit
Water-powered water pumps
Journey to Forever and AT
Chinese watering cans (with plans)
Hoe for victory!
Billhooks and sickles
A better rat trap
Rats and owls
Chinese rat trap
How to make a Chinese rat trap
Bucket rat trap
Appropriate technology subjects

Home

Appropriate technology resources

Lots of these resources are old -- some more than a century old. This is NOT because appropriate technology is nostalgic, it's because old references often contain valuable and useful information that simply is not available now.

It's not nostalgia, simply stating a fact, to recognize that a hundred years ago people were a lot more independent, had a much higher general level of practical skills, and were much less wasteful than we are today.

These old resources are a goldmine of appropriate technology. That so many of them are being reprinted today acknowledges this -- and that there's a ready market for them shows that a lot of people recognize it.

There's a growing trend among individuals in the developed countries to be more self-sufficient, less dependent on the pre-packaged infrastructure of modern society. There's a great deal in common between this movement and the need for appropriate technology solutions in the developing countries.

See also:
Appropriate technology resources for Agriculture
Appropriate technology resources for Wood
Community development
Rural development

Organizations

The **Intermediate Technology Development Group** (IT) was founded in 1966 by Dr E.F. Schumacher, author of "Small is Beautiful". IT is a sustainable development NGO that helps to build the technical skills of poor people in developing countries. IT's Technical Enquiry Service is a free service to individuals and organizations everywhere, supporting local development initiatives through high-quality technical information and professional advice on its use. It handles over 1,300 requests for information a year. IT Publications is the world's largest publisher and supplier of books and journals on appropriate technology. IT is engaged in a range of activities including research, technology development, field testing

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and commercialization, technical assistance, training, and advocacy, covering a wide range of subjects. IT believes that sustainable development is achieved only if the participants in the process are its architects. "Technology is only appropriate if its users are able to continue to adapt and innovate whatever the future brings." ITDG -- Practical Answers To Poverty:
http://www.itdg.org/home.html
IT Publishing's Development Bookshop -- browse categories, search titles, authors, ISBN, keywords:
http://www.developmentbookshop.com/categories.phtml

VITA -- Volunteers in Technical Assistance is a private, nonprofit appropriate technology group that supports people working on technical problems in developing countries with useful information and assistance. Established by scientists and engineers in 1959 to respond to technical inquiries from people in developing countries, it has since responded to more than a quarter of a million requests for information. Its mission is to empower poor people in developing countries to manage their own development. VITA implements its own long-term field projects in enterprise development, agriculture, rural rehabilitation, conservation, protection of the environment, renewable energy, and other sectors. It provides support to others via its international Inquiry Service using a roster of volunteer technical consultants and a specialized documentation centre, publication of a wide variety of technical manuals and papers, an electronic mail system and bulletin board network, an electronic newsletter, and a disaster information service. It is now also using digital radio networks and a low-earth orbiting satellite system, VITAsat.
http://www.vita.org/

VITA Publications: Technology References cover Agriculture and animal husbandry, Building and construction, Business, industry and crafts, Communication and transportation, Energy, Food processing, Health and nutrition, General resources, Stoves, ovens, & kilns, Water supply, Natural resources & conservation. The Understanding Technology Series covers similar areas -- scores of practical, well-written guides, available online in text-only format without diagrams and illustrations. Also Industrial Profile Series. Order direct from VITA. The Development Publications CD-ROM includes the Reference Guides, Understanding Technology Series and Industry Profiles, more than 150 of VITA's best publications, including The Village Technology Handbook, with all diagrams, charts and graphics for each document, for Windows, DOS and Mac.
http://www.vita.org/publications/

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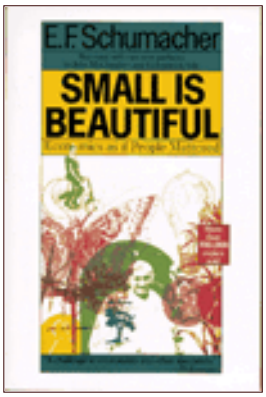
The **Nayudamma Information Bank** at the International Development Research Centre (IDRC) in Ottawa, Canada, is named after the late Dr. Yelavarthy Nayudamma, a man who dedicated his life to demonstrating how science and technology can and should be used for human benefit. The Bank provides information on the technologies supported by IDRC -- technologies from the South for the South, with contact names for all the technologies described. Covers agriculture, communication and information, economics, education, energy, engineering, environment, fishery, forestry, health.
http://www.idrc.ca/nayudamma/index_e.html

Village Earth: The goal of the Village Earth Project and the Consortium for Sustainable Village Based Development is to join together with other NGOs and individuals to help connect rural villages (two thirds of the world's population) to global resources -- including energy resources, information, appropriate technologies, social and financial resources -- for self-reliant, sustainable village-based development. Publishers of the Appropriate Technology CDROM Library and the Appropriate Technology Sourcebook (see below, Resources).
http://www.villageearth.org/

Resources



"Small Is Beautiful: Economics As If People Mattered", by E. F. Schumacher, HarperCollins, $14.00, ISBN 0060916303
This book has sold 700,000 copies -- no small figure for a book on economics. Required reading for anyone interested in development. If it had sold 7 million copies there'd probably be a lot less poverty, hunger and environmental degradation in the world than there is now.
Schumacher Society:
http://www.schumachersociety.org/
Intermediate Technology Development Group, founded by Schumacher in 1966:
http://www.itdg.org/home.html

"Village Technology Handbook"

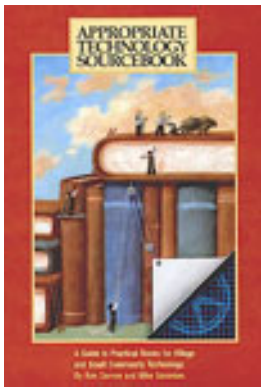
Volunteers in Technical Assistance (VITA), 3rd edition 1988, Vita Publications, ISBN 0866192751

One of the best resources for development workers and for self-sufficiency. Written to bridge the technical information gap that keeps the world's villages from learning from each other's experience. Easy to read, construction plans for a wide range of useful tools, implements and techniques. The first chapter is on water, which gets extensive coverage: principles of hydrology explain where underground water is likely to be found, types of wells, how to make well drilling tools, how to drill or dig the wells, lifting water from wells and transporting it, pumps and piping, including wind-driven pumps, charts and tables to calculate pipe size and water flow, water storage and purification. Further similarly useful chapters on Health and Sanitation, Agriculture, Food Processing and Preservation, Construction, Home Improvements, Crafts and Village Industry, Communications. Also available in French and Spanish. Order from VITA: http://www.vita.org/publications/refpub/vth.htm

Appropriate Technology CDROM Library

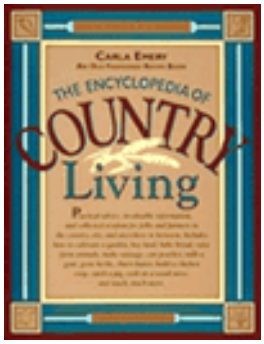
The most comprehensive, practical, and economical Appropriate Technology reference collection ever compiled. Complete text and images from over 1,050 of the best books on all areas of do-it-yourself technologies ... over 150,000 pages in a digitized format, on Mac and PC compatible CD-ROMs or Microfiche. Subjects covered include harvesting clean drinking water, making tools, growing your own crops, preserving crops, building and maintaining an irrigation system, reforesting a denuded watershed, starting a small fish hatchery, building a small-scale hydropower scheme, building and maintaining pumps, treating human and animal waste, utilizing solar energy, improving rural cookstoves, energy efficient structures, caring for the sick, non-formal education, preparing for a natural disaster, small industries, solar / wind / water / biogas power, transport, and much more. The only source for more than 100 out-of-print but sought-after materials like the "Complete Farmer's Guide" and "Small Earth Dams". Also includes such appropriate technology classics as Where There is no Doctor and the Village Technology Handbook. In use in over 130 countries by Peace Corps Volunteers, development and relief organizations, engineers, and missionaries. "In a country where books are scarce, this library is an important resource indeed. Already it has some readers' minds whirling as they realize 'we can do that technology here'." -- L.F., Mennonite Central Committee,

Laos. If you're only interested in a part of the Library, Village Earth now sells the Library broken-up into topical CDs. From Village Earth:
http://www.villageearth.org/ATLibrary/



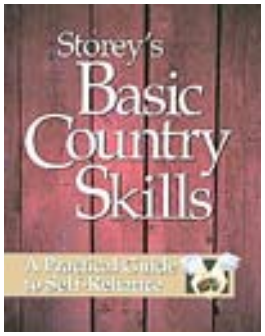
"The Appropriate Technology Sourcebook: A Guide to Practical Books for Small Community Technology" by Ken Darrow and Mike Saxenian, revised and enlarged edition, 1993, Consortium for Sustainable Village Based Development (CSVBD) ISBN 0917704185
The Sourcebook reviews 1,150 of the best books on appropriate technology. Invaluable, practical resource on small-scale technologies. "The best AT Bibliography for those who are actually getting their hands dirty" (The Whole Earth Catalog). "The world's best village machines" (Christian Science Monitor). "The only inventory in the English language that attempts to bring together the sum total of every relatively uncomplicated device... truly comprehensive" (United Nations Development Forum). Most of the books reviewed in the sourcebook are available in full in the Appropriate Technology Library on CD-ROM or Microfiche (see above). The Sourcebook is now online! -- in full, and with a search engine, at publishers Village Earth/CSVBD:
http://www.villageearth.org/atnetwork/atsourcebook/index.htm

"Teknologi Kampungan -- A Collection of Indigenous Indonesian Technologies" by Craig Thorburn, 1982, Volunteers in Asia, ISBN 0917704169
Third World technology for a more efficient world. Build a bamboo hand pump, spinning wheel, or potter's wheel, use bicycle parts to make a grinding wheel, wood lathe, or blacksmith's forge, construct a waterwheel electricity generator. Ideas and plans for both developing countries and people wanting to be more self-sufficient. Detailed drawings and descriptions. From Think!ECO Bookshop (Australia, ships international orders):
http://www.australiarealestateproperty.com/prod493.htm



"The Encyclopedia of Country Living -- An Old Fashioned Recipe Book" by Carla Emery, 9th edition 1994, Sasquatch Books, ISBN 0912365951
The homesteaders' bible -- Carla Emery published the first edition herself, more than 25 years ago, and it's since grown into an 800-page illustrated treasure of rural wisdom gleaned over the years from homesteaders and others. It's an all-embracing rural encyclopaedia, the complete resource for self-sufficient living. Grow a garden, milk a cow, catch a pig, pluck a chicken -- everything about food, growing it, storing it and cooking it, including hundreds of recipes, a wealth of practical information, detailed instructions, anecdotes, personal advice, suppliers, catalogs, books and magazines, organizations, how-to, where-to and why-to, and morsels of everything else from the highly personable Ms Emery. From Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=2-0912365951-0
Carla Emery's Web Site:
http://www.carlaemery.com/

"The Household Cyclopedia of General Information" compiled around 1881 by Dr. Harry Hartshorne of the University of Pennsylvania
"Practising and relearning the skills that once enabled people to live without the infrastructure our society provides -- the utilities, the shops, the readymade products -- can only be a good thing," says Matthew Spong, who has put this amazing book online. "It's the sort of book a pioneer of the old west would have packed carefully into his covered wagon before heading off for a boondock town. It was a book for people who need to be able, if the circumstances demand, to amputate a limb, grow their own fibre for material, take care of their horses, give birth to children, and build houses, concoct medicines, all with the minimum of help from others."
Covers Agriculture, Horticulture, Rural And Domestic Economy, Farriery, Medicine, Culinary Arts, Brewing, Distillation, Perfumery, Bleaching And Scouring, Dyeing, Staining, Paints And Colors, Varnishes, Lacquers, Cements, Glue, Inks, Metallurgy, Pyrotechny, Tanning, Enamelling, Pottery, Glass, Photography, Engraving, Weights And Measures, Chemical Reciepts, Weather Prognostics, Angling, Miscellaneous (long!), Implements Of Agriculture, Illustrations, Index.
http://www.publicbookshelf.com/public_html/The_Household_Cyclopedia_of_General_Information/



"Basic Country Skills: A Practical Guide to Self-Reliance" by Deborah Burns (Editor), 1999, Storey Books, ISBN 1580172024
"What Country Folk Know that You Don't." Like how to plant a cold and flu garden to make your winter healthier and happier. A manual for everyday survival, whether in town or country, especially on gardening -- more than a third of the 544 pages are devoted to gardening. More than 150 of Storey's expert authors in gardening, building, animal raising, and homesteading share their specialized knowledge and experience. Illustrated step-by-step instructions on how to milk a cow, tap a maple tree, clean a fish, lead a horse, build the best chicken coop -- how to be skilful! Full resource list and a complete index. From Storey Books:
http://www.storey.com/books/book.php/y/7/p/0/isbn/1-58017-202-4

"The Old Farmer's Encyclopedia: A Practical Compendium of Traditional American Wisdom and Know-how", The Lyons Press, ISBN 1-58574-155-8
Turn-of-the-century wisdom on every aspect of farm and country life. From the barn to the nursery, nothing has been overlooked. Divided into three parts that cover the land, the homestead, and leisure activities, with handy advice on livestock, barns and fences, farm machinery, manure, blacksmithing, beekeeping, the dairy, kitchen devices, canning and preserving, home remedies, sewing and quilting, toys and sports, whiskey making, county fairs, and more. From The Lyons Press:
http://lyonspress.com/gard_gen.asp

"The Design and Manufacture of Animal-Drawn Carts" by Ian Barwell and Gordon Hathway of I.T. Transport Ltd (UK), 1986, Intermediate Technology
Covers different types of carts and how to build them. Photographs and line drawings.
Two-wheeled carts, four-wheeled carts, tippers, bottom-dumpers, water-carriers, bodies, axles, wheels, suspension, horses, oxen, camels, harnessing and hitching, lots of detail. Most people in developing countries don't have transport. Often they don't even have roads. But the planners ignore every option that doesn't have a motor. So people usually use their legs to travel, and transport goods on their backs. There are many local alternatives,

but they get no support and are few and far between. This book is the first of a series by the ILO and UNCHS/HABITAT on low-cost vehicles. Animal-drawn carts have been used for hundreds of years in many countries, but there have been few attempts to explain the principles of good design or to describe suitable manufacturing methods using local materials and technologies. A few countries still have traditional cart-making skills, but most don't. Animal carts are cheap and efficient, they don't need much of a road, they're easy to build, and they're sustainable. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/

"Making Wheels: A Technical Manual on Wheel Manufacture" by R. A. Dennis, 1992, Intermediate Technology Development Group Publishing
A low-cost technology which will enable workshops to set up their own facilities and manufacture a range of wheels from standard steel sections. For those familiar with metalworking techniques. With technical drawings and sketches. From Stylus Publishing:
http://styluspub.com/books/book2731.html

The Jatropha System: "An Integrated Approach to Rural Development in Tropical & Subtropical Countries" -- use of the *Jatropha curcas* tree for erosion control, for enabling women, rural income generation, renewable energy production. Very nice project!
http://www.jatropha.org/

"The Manual Screw Press for Small-Scale Oil Extraction" by Kathryn H. Potts, Keith MacHell, 1993, Intermediate Technology, ISBN 1853391980
Manual oil extraction from peanuts or other soft oilseeds can be a viable enterprise for small businesses. Describes small-scale processes of oil extraction for use in rural areas, as well as ways to market and distribute the oilcake. From IT Publishing:
http://www.developmentbookshop.com/book.phtml?isbn=1853391980

"How to Make a Foot-Operated Workshop Drill" by Paul Smith, 1986
Drill up to 12mm diameter holes in 12mm steel plates. Full dimensions and assembly instructions. You need to make the machines in workshops with electricity and some power tools, but once made, they can be distributed to less well equipped rural areas

for use by village blacksmiths and workshops. Very clear diagrams. From Stylus Publishing:
http://styluspub.com/books/book2402.html

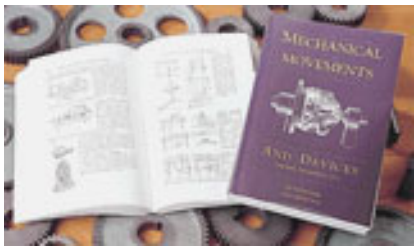
Lee Valley Tools has a great selection of classic reprints which they publish themselves -- well, books are tools aren't they? Have a look at their online catalog -- they keep adding new titles, so it's worth regular visits. 100-year-old classic editions of The Boy Mechanic and Popular Mechanics Shop Notes, The Open Timber Roofs of the Middle Ages, Mechanical Movements and Devices, Windmills and Wind Motors -- How To Build And Run Them (old ones), Traditional Woodwork, The Art of Fine Tools, The Craft of Log Building, How To Make Wooden Planes, Barn Plans & Outbuildings, Book of Trades, Fences, Gates & Bridges -- A Practical Manual, Lee's Priceless Recipes, and many more.
http://www.leevalley.com/

"The Boy Mechanic" by Popular Mechanics Co. (from 1913 to 1925), Classic Reprint Series.
"When these books were published , a major part of the population was agricultural and another major part was industrial, since the service sector had not yet become as significant as it is today. Both groups were familiar with tools and there was an assumed practical knowledge level that does not exist today. Published in that wonderful era of our history when people were much more independent and tended to make things rather than buy them, the four books have 3,849 articles and 3,917 illustrations for thousands of projects using new or recycled materials." These books were handed down from generation to generation. Not just for boys!
From Lee Valley Tools:
http://www.leevalley.com/

Popular Mechanics Shop Notes Series, 1905 to 1921, Classic Reprint Series.
Popular Mechanics began issuing their Shop Notes in 1905 as an annual collection of advice on jigs, fixtures, methods of work, processes and projects. The subheading for the titles, "Easy Ways to Do Hard Things", accurately describes the contents. The earlier issues had more emphasis on metalworking than woodworking but the focus was always on small shop practice. As years went by, the contents shifted more and more to woodworking and handyman projects. The advice is always direct and simple, using the tools available in a normal home shop. Clear, concise, and widely informative. The notes are profusely illustrated -- the early years have excellent line drawings and engravings, with some photographs only after 1920. Lee Valley Tools has reprinted issues 1905 to 1921, with another eight volumes (1922 to 1929) being

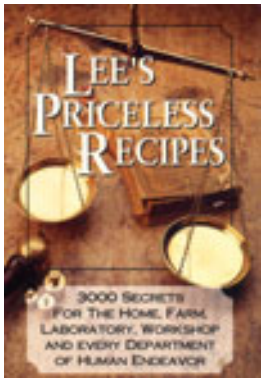
reprinted at one per month -- 1922 will be available in January, 2001.
http://www.leevalley.com/

"Mechanical Movements and Devices" by Gardner D. Hiscox, 1911, Classic Reprint Series.
The ultimate book on mechanisms and mechanical devices -- 1,800 illustrations (with explanations) of mechanisms as simple as a pulley and as complex as a steam engine. The author's intent was to



capture all of the mechanisms designed from the beginning of time until the publication of the book. It predates the age of widespread electric power and the internal combustion engine, so it focuses on individual mechanisms. The section on the transmission of power by the use of ropes is worth the price of the book. But the greatest value is in the ideas it generates for creating simplified methods of work. Combinations of basic tools (lever, wedge, wheel, etc.), power transmission through ropes, belts, gears, etc., to achieve alternating intermittent or variable motion, steam, air and water-powered mechanisms, gearing, motion control, clock mechanisms, construction devices, mill mechanisms. From Lee Valley Tools:
http://www.leevalley.com/

"507 Mechanical Movements" by Henry T. Brown, 1893, Classic Reprint Series.
This is a compendium of "all those (mechanical movements) which are most important in dynamics, hydraulics, hydrostatics, pneumatics, steam engines, mill and other gearing, presses, horology, and miscellaneous machinery", carefully drawn and described. He included gears, pawls, sheaves, governors, instruments and joints, in ingenious and practical combinations -- all the small parts that make up complex machinery. With a good index, this volume is an excellent source book for technological history, as well as a practical design reference. From Lee Valley Tools:
http://www.leevalley.com/



"Lee's Priceless Recipes" compiled by Dr. N.T.Oliver, Chicago, 1895, Laird & Lee, Reprint 1998, Algrove Publishing, ISBN 0-921335-17-2
"3000 secrets for the home, farm, laboratory, workshop and every department of human endeavor" -- Victorian how-to's like this one professed to include virtually all knowledge to date. It certainly covers an extraordinary range. Even if these were secrets, you nonetheless get the idea that Victorians knew how to do a great many more things than we do, even if they couldn't program a video. And that they had a vast range of materials, ingredients and chemicals to choose from, very many of which it would be hard to find now, in this age of pre-packaged ready-mades. One is left with a sense of loss. It's a fascinating book, and a lot of it is downright useful. From Lee Valley Tools:
http://www.leevalley.com/

Home Power magazine is the premier publication on home-scale renewable energy and solar power -- current issue (free download), files and downloads, educational resources, two sets of Web resources: Renewable Energy (RE) sites links, and Other links, and products: Solar2, Solar3, and Solar4 CD-ROMs, books, videos, back issues.
http://www.homepower.com

"Box Beam Sourcebook" by Phil Jergensen, 1994, Suntools, ISBN 9994777866
How to build modular shelter, greenhouses, furniture, many kinds of electric vehicles, a mini-tractor, wind generator, solar concentrator, and much more. Make everything from your bed to a portable home to an electric vehicle with components you can recycle yourself thousands of times. A revolution in building design and construction -- cheap, versatile, and easy. Anyone can use these simple methods and designs, save hundreds of dollars, and build things to their exact specifications. "Appropriate technology at its best." From Think!ECO Bookshop (Australia, ships international orders):
http://www.australiarealestateproperty.com/prod498.htm
See also "Tri-joint XYZ Matrix Construction":
http://www.netside.com/~lcoble/dir9/tryjoint.txt

Lehman's Non-electric Catalog -- "Serving the Amish and others without electricity with products for simple, self-sufficient living since 1955." Everything you need to go back to the land,

from the people who never left it in the first place. Stuff here from all over the world -- German pressure lanterns, Chinese anvils, South African 3-legged cast-iron cooking pots, scythes from Austria, high-quality, along with built-to-last-forever goods made by local Amish craftsmen, lots of basic, sensible items you just don't find anywhere these days. Order online. Site search.
http://www.lehmans.com/

Appropriate communities

The **Global Ecovillage Network** (GEN) is a grassroots non-profit organization that links ecovillages and related projects around the world. "GEN promotes and supports models of sustainable living globally, in order to inspire and encourage the creation of more viable lifestyles on this Earth." Eco-village Directory (by country or by region), resource database (from agriculture to water), Ecovillage Millennium newsletter, links, FAQ, site search.
http://www.gaia.org/
Global Ecovillage Network Forum - both a web forum and a mailing list
http://www.gaia.org/webboard/

Intentional Communities Home Page -- "Intentional Community" is an inclusive term for ecovillages, cohousing, residential land trusts, communes, student co-ops, urban housing cooperatives and "other related projects and dreams..." Provides information and access to resources for intentional communities. 600+ communities described in the Communities Directory (book and online), Communities magazine - Journal Of Cooperative Living (back issues online), long list of links to community associations, Web resources, books, site search.
http://www.ic.org/
Intentional Communities e-mail group:
http://www.ic.org/in/emailgrps.html

Appropriate technology
Appropriate technology resources
- Agriculture resources
- Wood resources
Blacksmithing
Wood fires that fit
Houses that fit
Water-powered water pumps
Journey to Forever and AT

- Chinese watering cans
- Handmade Projects watering can plans
- Hoe for victory!
- Billhooks and sickles

A better rat trap

- Rats and owls
- Chinese rat trap
- How to make a Chinese rat trap
- Bucket rat trap

Appropriate technology subjects

Community development | Rural development
City farms | Organic gardening | Composting | Small farms | Biofuel | Solar box cookers
Trees, soil and water | Seeds of the world | **Appropriate technology** | Project vehicles

Home | What people are saying about us | About Handmade Projects
Projects | Internet | Schools projects | Sitemap | Site Search | Donations | **Contact us**

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Appropriate technology
Appropriate technology resources
Agriculture resources
Wood resources
Blacksmithing
Wood fires that fit
Houses that fit
Water-powered water pumps
Journey to Forever and AT
Chinese watering cans (with plans)
Hoe for victory!
Billhooks and sickles
A better rat trap
Rats and owls
Chinese rat trap
How to make a Chinese rat trap
Bucket rat trap
Appropriate technology subjects

Home
What people are saying about us
About Handmade Projects
Sitemap (text only)

Appropriate technology resources

Agriculture

"Tools for Agriculture: A guide to appropriate equipment for smallholder farmers" by Ian Carruthers and Marc Rodriguez, 4th edition 1992, Intermediate Technology, ISBN 185339100X
Unique guide to small-scale farming equipment. Each subject is introduced by an expert who sets the available tools against the background of good farming practise. Helps you evaluate what's most suitable for your situation. Analyses why some projects are successful and suggests ways to improve them. Land preparation, sowing and fertilizing, pest control, harvesting, water lifting, livestock care, beekeeping. With lists of manufacturers (mostly in the Third World). From Intermediate Technology Development Group: http://www.developmentbookshop.com/book.phtml?isbn=185339100X

"Tools for Organic Farming -- A Manual of Appropriate Equipment and Treatments", George McRobie (editor), 1989, Intermediate Technology, ISBN 1853390097
Small-scale and relatively affordable equipment for organic farmers, wherever they are in the world, with the emphasis on developing countries. Warns against chemical pesticides and describes how to use natural crop protection methods. Lists suppliers and manufacturers. The sustainable production system, Crop protection, Seed bed preparation and intercultivation, Sowing, planting, and fertilizer distribution, Harvesting and post-harvest crop processing, Appendix on water-lifting pumps and other equipment, Manufacturers' index. From ECHO's Global Bookstore: http://www.echotech.org/bookstore/

ECHO -- Educational Concerns for Hunger Organization -- is a non-profit, Christian organization dedicated to the fight against world hunger. The focus is on subsistence tropical agriculture, but this is a great resource for small farmers everywhere, or anyone with a garden. Excellent series of 40 technical notes -- broad topics and specific crops, from beehives in the tropics to organic neem pest control. ECHO Development Notes (EDN) is a technical networking bulletin on tropical agriculture, techniques, plants, resources, to improve food production in the tropics. Full text online. ECHO seed bank of tropical food, fuel, and soil-improving plants -- supplies seed of useful plants in small trial packets for experimentation in the field, seed catalog of unusual garden vegetables for sale (North America). ECHO Canada is a sister organization founded for and by Canadians. Links to websites with useful information.

Projects
Community development
Why we're doing this
Rural development
Fixing what's broken
City farms
Edible cities
Organic gardening
Everyone can grow their own food
Composting
The Wheel of Life
Small farms
The way forward
Biofuels
Fuel for the future
Solar box cookers
Sun power saves lives and trees
Trees, soil and water
Healthcare for mountains
Seeds of the world
No seeds, no food
Appropriate technology
What works and fits
Project vehicles
The workhorses

Internet
Why it really matters
Internet interaction
Finding your way

Schools projects
Introduction
Biofuels
Solar box cookers
Backpack stove
PicoTurbine
Low-tech radio
What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox
School gardens

http://www.echonet.org/

ATTRA -- Appropriate Technology Transfer for Rural Areas (US) concentrates on sustainable farming information. Large and well-selected set of resource links on sustainable farming, US and worldwide, from what-is to how-to. Technical assistance, publications, and resources. ATTRA's on-line guides are some of the best resources available. Systems Guides, Technical Notes, Resource Lists, includes Farmer Profiles: ATTRA Materials List, Fundamentals of Sustainable Agriculture Series, Agronomy Series, Horticulture Series, Livestock Series, Pest Management Series, Soil and Fertility Series, Marketing & Business Series, Value-Added & Processing Series, Alternative Farming Systems Series, Resource Series, Planting Your Farm's Future Leaflets.
http://www.attra.org/

"Handy Farm Devices and How to Make Them" by Rolfe Cobleigh, Orange Judd Company, 1910
Not just nostalgia -- Cobleigh's devices and techniques were good answers to common farm problems and they're just as functional and useful now as they were then. Make your own workshop tools, a simple fence post and stump-puller, fences and gates that don't sag, building a farmhouse, barns and outbuildings, a bicycle-powered washing machine, a dog-powered pump, a lightweight orchard ladder, a portable chicken coop, a stone boat (for moving stone) and much more. Cobleigh's out to save you time and money -- a treasure for small farmers or homesteaders and anyone wanting to be more self-sufficient. Illustrated, good old-style writing, punctuated with quotes from Shakespeare or a local farmer, whichever's apt. Full text online in the **Small Farms Library**.

"Farm appliances and how to make them" by George A. Martin, 1887, Reprint edition 1999, The Lyons Press, ISBN 1558218882
Lots of useful gadgets and equipment, time-saving and easy-to-make, for the farm, garden, homestead -- wells and irrigation, a cart for breaking colts, a sheep-shearing bench and more, plus loads of tips and advice. Well illustrated with line drawings, and the usual clear, entertaining writing of the era -- bags of charm. Order online from Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=2-1558218882-0

"Farm Conveniences and How to Use Them" Anonymous, 1884, Reprint edition 1998, The Lyons Press, ISBN 1558217274
This is a collection of the best techniques used by late-19th century American farmers, and a real gift

School composting
Trees and forests
The Beach House fish pond
HOMeR
Eco-footprint
School and youth programs on the Web
Education resources on the Web
Children's poetry

Contact us

To Keith Addison
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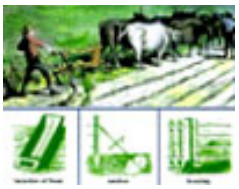
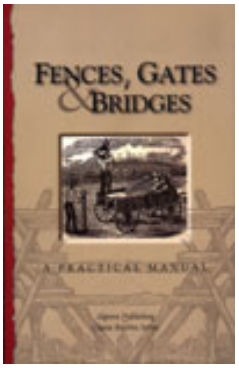
To Midori Hiraga
midori@journeytoforever.org
Homepage
http://journeytoforever.org/

Handmade Projects
Ichijima
Japan



for small farmers and back-to-the-landers today. Full of savvy and practical know-how on a wide variety of farming jobs. Sheds and shelters, traps, fences and gates, carts, using manure, erosion control and more. From Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=1-1558217274-1



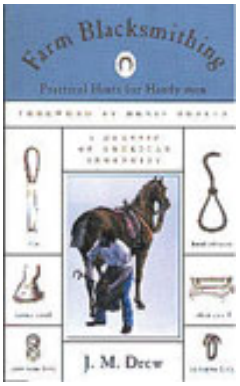
Fences, Gates & Bridges -- A Practical Manual", George A. Martin, 1892, reprint in 1999, Algrove Publishing, ISBN 0-921335-62-8
This book predates the widespread use of wire fences, though there is a section on wire and barbed wire. It describes traditional fencing methods in detail, with excellent engravings and line drawings. Covers all kinds of fences, made of sod, stone, saplings, boards, pickets, a wide variety of hedges to contain animals, strong on gates, wide variety of styles and techniques for preventing sag, also wickets and stiles. The bridges are the small ones a small farmer might need. From Lee Valley Tools:
http://www.leevalley.com/

"Barn Plans & Outbuildings", Byron D. Halsted, Orange Judd Co, 1881, 1889 edition reprint 1999, Algrove Publishing, ISBN 0-921335-64-4
Excellent engravings, woodcuts and line drawings of the full range of farm buildings, from giant barns to dog kennels, many with floor plans and key construction information. General Farm Barns, Ice Houses, Dairy Houses, Corn Houses and Cribs, Cattle Shelters, Spring Houses, Sheep Barns and Sheds, Granaries, Etc., Poultry Houses, Root Cellars and Root Houses, Piggeries, Dog Kennels, Cattle Barns and Stables, Bird Houses, Smoke Houses, Ice Houses and Cool Chambers, Dairy Barns, Carriage Houses, The Preservation of Fodder in Silos -- very good section on making silage. From Lee Valley Tools:
http://www.leevalley.com/

Hillside poultry house -- Barn Plans & Outbuildings

"Farm Mechanics" by Fred D. Cranshaw, 1922, Classic reprint Series.
Focuses more on general self-efficiency than on agricultural practice. When it was published farms had to be much more self-sufficient than today -- a farmer had to be familiar with woodworking, blacksmithing, concrete work, sheet metal work, farm machinery repair, and general rope and harness work. Covers a daunting range of subjects, using a straightforward approach to teaching the basics in each area using a wide range of examples. The book was used in

agricultural extension courses of the day. From Lee Valley Tools: http://www.leevalley.com/
Full text online at Cornell University's Core Historical Literature of Agriculture Library: http://chla.mannlib.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2840012

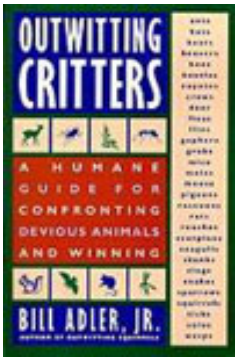


"Farm Blacksmithing: Practical Hints for Handy-Men" by James M. Drew, Denis Boyles, 2000, The Lyons Press, ISBN 1585740977
Time-honored instruction on all the essential skills of farm blacksmithing. Complete, no-nonsense guide first published a hundred years ago, covers both history and craft. Begins with the basics: how to set up a blacksmith shop, use of essential tools, selecting materials; goes on to a complete education in the most essential techniques. Step-by-step course in forging a wide variety of useful items from cutlery, candlesticks, and lanterns to horseshoes and handy farm devices. Illustrations throughout. Part of The Lyons Press series of authentic Americana from the turn of the century. From Backwoods Home: http://www.backwoodshome.com/store/files/ss32.html
Full text online at Cornell University's Core Historical Literature of Agriculture Library: http://chla.mannlib.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2734502

"The Scythe Book" by David Tresemer, 1981, Reprint 1996, Alan C. Hood, ISBN 0-911469-14-1
"In this age when most wonder how you can accomplish anything without the aid of electricity or gasoline, we must reassert that a hand tool finely made has greater versatility, has comparable efficiency even in large areas, and even makes for good exercise because the tool fits the dynamics of the body. Most importantly, a finely made tool does not interfere with personal communion with the ever-amazing natural world." A well-researched manual on the (almost) lost art of using a scythe: how to use a scythe with little effort. Tresemer delves into subjects such as the Alexander Technique, relaxation and mind-body techniques to explain the relaxed, natural swing that cuts the best -- Zen and the art of the scythe (though he doesn't say so). Interesting recounting of the history of the scythe (it took about 2,000 years to develop it). Includes sections on scythe maintenance and harvesting and processing small grains. A real pleasure to read. From Lehman's Non-electric: http://www.lehmans.com/cgi-bin/ncommerce3/ExecMacro/lehmans/prodimage.dw/report?prrfnbr=14487&FROM_CAT_REF=12822&FROM_PROD_REF=

Scythe Supply offers high-quality European-style scythes, scythe blades, snaths, whetstones, hammers, anvils and equipment. "We are

scythe enthusiasts and want others to discover this wonderful tool." Lots of content and a workshop section with how-to explanations and photos.
http://www.scythesupply.com/



"Outwitting Critters" by Bill Adler, Jr., The Lyons Press
Dealing with "pests" in a compassionate, ecological style, by the best-selling author of Outwitting Squirrels, Outwitting Bears, and Outwitting Neighbors. Adler lists hundreds of tricks to fend off trespassers in this definitive guide for coping with the nettlesome side of nature. "Think like the critter your want to outwit. Get down on your hands and knees and look at the world from the animal's point of view." Roaches in the kitchen, deer in the garden, from ants to raccoons to wasps, time-tested methods for humanely ridding your house and yard of unwanted critters. "Covers a wide range of animals and solutions ... a useful, fact-filled book." -- San Francisco Chronicle. From The Lyons Press:
http://lyonspress.com/gard_gen.asp

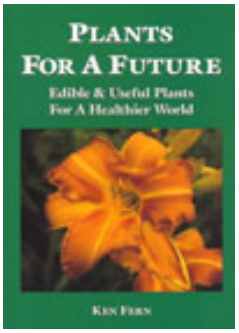
"Gardening for Better Nutrition" by Arnold Pacey, 1978, Women Ink, ISBN 0903031507

Covers the basic technology of horticulture and vegetable-growing, mainly for family gardens in developing countries. Deals with the way vegetable growing has been encouraged by health service workers and nutritionists. It describes alternative kinds of agricultural extension work which are likely to meet the needs of women. Based on field reports and case histories. The second in a series of manuals on "Socially Appropriate Technology". From ITDG Development Bookshop:
http://www.developmentbookshop.com/book.phtml?isbn=0903031507
From Stylus Publishing:
http://www.styluspub.com/Books/BookDetail.aspx?productID=45432

"New Crops: Solutions for Global Problems" -- excellent article by Noel Vietmeyer of the New Crops project. "In Africa, where the hunger problem is concentrated, there are actually 2,000 species of native food plants. Both there and in the rest of the tropics, the region where malnutrition is severest, can be found 3,000 different fruits as well as over 1,000 vegetables. In the lands where deforestation is so destructive are to be found over 20,000 trees, some of them extremely fast growing. In the desertifying regions can be found many useful drought-tolerant plants -- I don't know how many, but it runs into the hundreds. Despite the existence of all this herbaceous heritage, hardly any tropical plant is being employed to full advantage to relieve the pervasive problems. Of Africa's 2,000 food plants, only sorghum gets major research. Of the 3,000 fruits, only banana and pineapple get solid global support, and again much of the effort is aimed at helping the rich

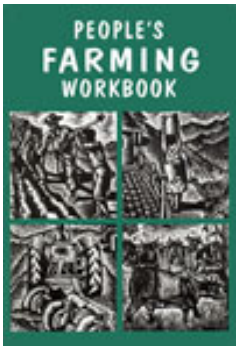
rather than the needy. Of the 20,000 tropical trees, only a handful are undergoing global advancement. That the bulk of useful tropical biodiversity is underexploited is one of the glaring oversights of this era. The creation of more crops and the support for new-croppers is of global importance." Read on!
http://newcrop.hort.purdue.edu/newcrop/proceedings1996/V3-002.html

The **New Crop Resource Online Program** at Purdue University, includes CropSEARCH -- a key word search engine to access crop information, CropINDEX -- a list of scientific and common names of crops for information access, CropREFERENCE -- books and manuals on crops, Aromatic-MedicinalPLANTS -- a guide to aromatic & medicinal plants, culinary herbs and spices, NewCrop LISTSERV -- an interactive bulletin board for queries, discussion, and information on crops, and much more. Easy access to a huge set of resources on crops new and old, trees, plants of all kinds. "The most comprehensive library and compilation of new and alternative crop information available on the web." Very useful indeed.
http://www.hort.purdue.edu/newcrop/



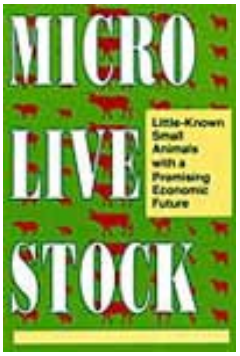
"Plants for a Future: Edible and Useful Plants for a Healthier World" by Ken Fern, 2000, Permanent Publications, ISBN 1856230112 The way we currently produce our food is damaging both to ourselves and our planet. We need to create gardens, woodlands and farms which are in harmony with nature. What we need is to discover and grow a wide variety of easily grown perennial and self-seeding annuals which provide delicious and healthy food, or are useful in other ways. Describing plants such as these, native to Britain and Europe and from temperate areas around the world, this book includes those suitable for: the ornamental garden, the edible lawn, shade, ponds, walls, hedges, agroforestry and conservation. Packed with information, personal anecdote and detailed appendices and indexes, this pioneering book takes gardening, conservation and ecology into a new dimension. "Ken Fern leads us through a garden of improbable delights -- cold climate yams five feet long, edible fuschia fruits, trees laden with delicious berries all through the winter, leaves and flowers with the most subtle and astonishing flavours. It is hard to over-estimate the importance and likely impact of this book. The result of an insatiable curiosity and years of painstaking research, this book is comparable in stature only to the works of Evelyn and Culpeper." -- George Monbiot, The Guardian. Order from Plants For A Future:
http://www.comp.leeds.ac.uk/pfaf/book.html

Plants For A Future -- Database Search has a wide variety of powerful searches of very large plant resources. Search by Name (common or family), Edible, Medicinal or Other Use, Native Area, Habitat, word search, Latin names. You can download the database for your own use.
http://www.ibiblio.org/pfaf/D_search.html



"People's Farming Workbook", Environmental and Development Agency Trust, 1995, David Philip, Cape Town, South Africa, ISBN 0 86486 112 5
For rural and resource-poor communities. The Workbook has obviously grown from the ground up, like a good crop: written by a collective, the authors know the needs of the grass-roots people the book targets. It's easy to read and easy to use, well-illustrated and well-organized to meet the needs of everyone from small farmers to backyard gardeners with little time and few resources. Simple without being simplistic, it's a mine of sheer usefulness -- an object-lesson for some of the expensive, top-heavy programs that set out to help poor rural people. Applicable anywhere in the Third World, not just South Africa. From David Philip Publishers, Cape Town, South Africa. E-mail: dpp@iafrica.com fax: +27 21 64 3358
From Stylus Publishing:
http://www.styluspub.com/Books/BookDetail.aspx?productID=45177

"Amaranth to Zai Holes: ideas for growing food under difficult conditions" by Laura S. Meitzner and Martin L. Price, 1996, ECHO (Educational Concerns for Hunger Organization). This book is an updated compilation of 15 years of ECHO's quarterly technical bulletin, ECHO Development Notes. "Amaranth is a drought-tolerant plant which provides both high-protein grain and delicious edible leaves. Zai holes use termites to improve soil fertility and increase water filtration in farmers' fields in West Africa. These are just two of the plants and techniques people are using to produce food under difficult growing conditions in the tropics." A treasurehouse of practical information for and from the field, mainly for people working with small farmers or urban gardeners in Third world settings -- new ideas, techniques, underutilized tropical plants, and offers of trial packets of seed to evaluate them. Online version (free online registration):
http://www.echotech.org/network/modules.php?name=AZ
Order the book online:
http://www.echotech.org/bookstore/



"Microlivestock: Little-Known Small Animals with a Promising Economic Future", 1991, Board on Science and Technology
Small animals require less feed and space and are easier to care for. This fascinating report makes suggestions for replacements for conventional livestock. Covers the microbreeds of cattle, goats, sheep, pigs, many breeds of poultry, rodents, deer, rabbits, lizards, and others, with appearance, distribution, habitat, biology, behaviour, care, pros and cons, and research needs. Read it online (free) or print it out at the

National Academy Press:
http://www.nap.edu/books/030904295X/html/

"Microlivestock" -- The Overstory #41
In many parts of the world the major protein sources are not "farm animals" but instead "microlivestock" -- small animals managed for food. There are over a thousand kinds of reptiles, rodents, insects, birds, and other small animals that can be categorized as microlivestock. Microlivestock have been essential to human nutrition for thousands of years. In the future, these small animals may be major players in food security, environmental conservation, and economic diversity.
http://www.agroforester.com/overstory/overstory41.html

"Cornucopia II -- A Source Book of Edible Plants" by Stephen Facciola, Kampong, ISBN 0962808725
Encyclopaedia of about 3,000 edible plants, alphabetical listing of plant families with 300 pages describing 7,000 varieties, especially traditional and heirloom varieties, as well as promising new releases. Habitat, origin, cultivation, preparation, modern and ancient uses, and 1,300 sources for seed, plants and rootstock, produce and other foodstuffs. In addition to common and botanical name cross-referencing there is an index of plants listed by use and edible parts. Wonderful work of scholarship. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/

"Controlling Crop Pests and Diseases" by Rosalyn Rappaport, 1992
Covers pest and disease damage, causes and controls. Manual and cultural techniques, Integrated Pest Management. Village-available insecticides: cheap, available and much safer alternatives to chemical pesticides, using improvised ingredients. Also keeping animals out of the garden with hedges, ditches and strips, windbreaks. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/

See also:
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Small farms library
City farms
Organic gardening
Composting

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- Wood resources

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Wood fires that fit
Houses that fit
Water-powered water pumps
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- Chinese watering cans
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- Hoe for victory!
- Billhooks and sickles

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Wood

"Wood Harvesting with Hand Tools: An Illustrated Training Manual" International Labour Office (ILO), 1987
This manual provides basic information on efficient and safe equipment and methods for manual wood harvesting, and helps to ensure full utilization of the raw material. It combines and updates two previous ILO publications: Felling and cross-cutting of tropical trees in natural forests (1969); and Selection and maintenance of logging hand tools (1970). Wood harvesting with manual tools continues on a large scale and, with a shift of emphasis to trees grown by rural people, will continue to gain importance. This manual fills a need for information on basic wood harvesting, excluding machines and techniques which in many developing countries are out of reach of the rural population (chainsaws). It also draws on Central European and Scandinavian resources where experience in manual logging in previous periods has been kept alive, with ongoing improvement of manual tools and techniques. The manual uses simple terms and lots of clear drawings. From ECHO's Global Bookstore: http://www.echotech.org/bookstore/

Pole lathes

The pole lathe is one of man's oldest woodworking machines. Powered by the turner's foot, a cord, and the springiness of a green wood pole, a pole lathe could be set up anywhere in the forests and used to turn green wood products on the spot.

They were used by bodgers, skilled craftsman who made wooden chairs and a lot of other forest products from greenwood using a pole lathe deep in the woods. They're still used today by modern-day bodgers.

Green woodwork uses fresh-cut poles and cleft wood rather than seasoned sawn timber and planking. Green wood "works"

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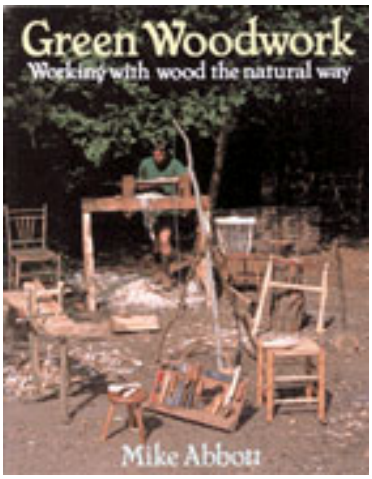
Turned on a pole lathe

Great pictures of an ancient pole lathe at work: http://www.gallica.co.uk/celts/polelath.htm

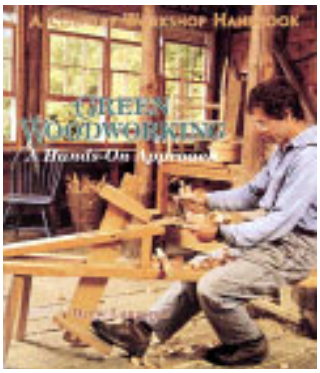
differently, bends more easily, cleaves well, allows for glueless joints, and cuts well on a pole lathe. Windsor and ladderback chairs are traditionally made of green wood. Other products are stools, hurdles, tent pegs, spoons, tool handles, rolling pins and more. Once fashioned, the wood is dried in a simple kiln.

Pole Lathe Turning -- 2,800-word article on pole lathes, what they are, what they do, how to use them, and how to build one, with diagram.
http://members.lycos.co.uk/handforged/polelathe.html

"Green Woodwork -- Working with wood the natural way" by Mike Abbott, Guild of Master Craftsmen, 1989, reprint 1999, Sterling Publishing, ISBN 0946819181



Abbott uses axes for rough sizing, saws for cutting to length, froes for splitting to proper dimensions, a few edged tools such as drawknives for shaping, braces and bits for fashioning holes, and a pole lathe for turning. Detailed discussion on the design and making of a pole lathe and a shaving horse. Chair making, utensils, fences, rakes, brooms and more. From Powell's Books:
http://www.powells.com/cgi-bin/biblio?inkey=62-0946819181-0



"Green Woodworking: A Hands-On Approach" by Drew Langsner & Carol Taylor, 1995, Lark Books, ISBN 0937274828.
Basic information for traditional woodworking with hand tools. Chapters on materials, tools (including sharpening), setting up a shop, followed by sections on

Biofuels
Solar box cookers
Backpack stove
PicoTurbine
Low-tech radio
What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox
School gardens
School composting
Trees and forests
The Beach House fish pond
HOMeR
Eco-footprint

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Children's poetry

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Ichijima
Japan

various techniques: knife-work, hewing, riving, shaving, boring, bending, and joinery. A sample project with each technique. From Country Workshops Woodworking School, started by Drew Langsner in 1978:
http://www.countryworkshops.org/toolbooks.html

Also great woodworking tools -- adzes, carving knives (straight, hooked), chairmaker's tools (inshaves, travishers), drawknives, gouges (bowl carver's and sculptor's), axes (carving, hewing, forest, camping), riving tools (splitting froes), from the Country Workshops Store:
http://www.countryworkshops.org/store.html

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Blacksmithing

With an anvil and a hammer a blacksmith can make everything else he needs. Then he makes everything everyone else needs: the farmers, builders, carpenters, craftsmen, householders, cooks.

(Bealer)

Tools for Self Reliance: Practical Help to Practical People Overseas
-- "In the struggle to develop, bare hands are not enough -- Could you work without tools?" This British charity supports workers in some of the world's poorest countries by providing basic hand-tools and promoting local tool-making. TFSR refurbishes second-hand hand tools and sewing machines collected from British homes and sends them to community groups in Africa. It also supports the makers of tools -- Africa's blacksmiths. With tools sent from Britain they have already made well over a million items, now in daily use in their communities. The blacksmiths provide tools to artisans, including farmers, many of whom are women, and offer an accessible, cheap source of repair work. It also supports blacksmith training programs in Tanzania, Zimbabwe and Sierra Leone.
http://www.tfsr.org/

"The Blacksmith and the Farmer -- Rural Manufacturing in Sub-Saharan Africa" by David Poston, 1994, Intermediate Technology, ISBN 1853391271
Poston's recognition of the significance of traditional blacksmithing to rural economies came during a study visit to Zaire and Zambia in 1986. "The Manie blacksmiths' cry for tools with which to work resulted in five weeks spent making tools with them in 1987. The very positive results of this second visit and the realization that the blacksmiths are able to develop themselves and their colleagues led to a third visit in 1988, at the blacksmiths' request." This led to a job invitation from the Intermediate Technology Development Group and further projects in Malawi, Zimbabwe and Tanzania. This book is the result, along with experiences of ITDG program workers. From IT Publishing:
http://www.developmentbookshop.com/book.phtml?isbn=1853391271

"The Survival of the Fitter: Lives of some African engineers" by John Powell, 1995, Intermediate Technology, ISBN 1853393169
Traces the development of Ghana's informal engineering sector through

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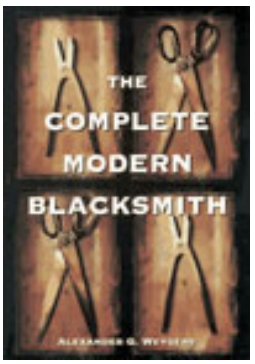
the progress of the actual people involved. The first generation of grassroots engineers are wayside vehicle mechanics, or "fitters", engaged in repairing machinery. Powell shows how the fitter's evolution to a manufacturer of tools, machines and equipment serving a wide range of "secondary" urban and rural industries, is central to progress in engineering, and that engineering and engineers are central to the development of an economy. From IT Publishing: http://www.developmentbookshop.com/book.phtml?isbn=1853393169

"Basic Blacksmithing -- An Introduction to Toolmaking With Locally Available Materials" by David Harries and Bernhard Heer, 1993, Stylus, ISBN 1853391956
Learn to make or repair tools and many other metal products. Basic and advanced rural blacksmithing techniques and step-by-step instructions on how to make a range of tools and useful items from scrap metal. Builds on traditional techniques and describes how to set up your own workshop with bellows, hearth, and anvil. Hundreds of diagrams. From ECHO's Global Bookstore: http://www.echotech.org/bookstore/

"The Art of Blacksmithing" by Alex W. Bealer, 1969, Revised edition 1995, Castle Books, ISBN 0-7858-0395-5
Bealer is credited with single-handedly bringing the ancient art of blacksmithing back from the edge of extinction in the Western world. His book sparked a revival of interest and now, 30 years later, blacksmithing is a thriving craft with thousands of practitioners. The book takes a close-up look at blacksmithing through the ages, showing how blacksmiths worked, what they made and how they made it. How to set up a shop, build a forge, detailed drawings and plans -- over 500 illustrations.



"The Complete Modern Blacksmith" by Alexander G. Weygers, 1997, Ten Speed Press, ISBN 0898158966
Compilation of three previous books, The Making of Tools, The Modern Blacksmith, and The Recycling, Use and Repair of Tools. Sculptor-artist-blacksmith Weygers wrote these books 30 years ago as notes to his lectures and courses on blacksmithing and they've been in constant demand ever since. Part of the course was making a set of tools which were worth more than the course cost! Weygers wouldn't buy anything he could make, and emphasizes recycling and scrounging raw material. Well illustrated, full of wit, wisdom and cunning technique.
More about the author at the "Alex Weygers Renaissance Man" website:

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Sisters of silk
Silkworms in a shoebox
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School composting
Trees and forests
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Children's poetry

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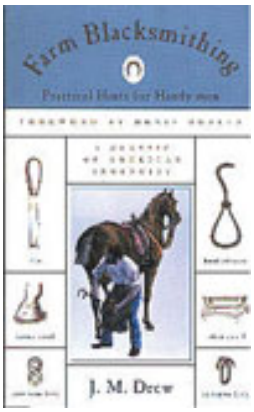
http://www.alexweygers.com/



"Farm Blacksmithing: Practical Hints for Handy-Men" by James M. Drew, Denis Boyles, 2000, The Lyons Press, ISBN 1585740977
Time-honored instruction on all the essential skills of farm blacksmithing. Complete, no-nonsense guide first published a hundred years ago, covers both history and craft. Begins with the basics: how to set up a blacksmith shop, use of essential tools, selecting materials; goes on to a complete education in the most essential techniques. Step-by-step course in forging a wide variety of useful items from cutlery, candlesticks, and lanterns to horseshoes and handy farm devices. Illustrations throughout. Part of The Lyons Press series of authentic Americana from the turn of the century. From Backwoods Home:
http://www.backwoodshome.com/store/files/ss32.html
Full text online at Cornell University's Core Historical Literature of Agriculture Library:
http://chla.mannlib.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2734502

"Blacksmithing" by James M. Drew, 1935, Webb Book Publishing Company
Drew was former Instructor in Blacksmithing at the School of Agriculture, University of Minnesota.
General blacksmithing, with the focus on the farm shop. Well illustrated with line drawings. Full text online at Cornell University's Core Historical Literature of Agriculture Library:
http://chla.mannlib.cornell.edu/cgi-bin/chla/chla-idx?notisid=ABN5768

"New Edge of the Anvil -- A Resource Book for the Blacksmith" by Jack Andrews, 1977, revised edition 1994, SkipJack, ISBN 1879535092
Comprehensive guide for the beginner or a reference for the advanced metalworker, covers tools, equipment, processes, with photographs of the work of historical and contemporary master smiths, with tables and charts, clearly written explanations. Thorough coverage of all aspects of blacksmithing. This book is currently used as a text at many schools and workshops. Order online from SkipJack Press:
http://www.bookmasters.com/skipjack/

"Practical Blacksmithing Vol I, Vol II" by M.T. Richardson, 1899, reprint 1998
A basic resource for today's blacksmith. Volume I begins with an account of the tools and equipment of the blacksmith, shop plans, diagrams demonstrating various smithing techniques, iron and steel, basic processes such as drilling, fullering, and swaging. Volume II covers various processes such as welding, brazing, soldering, forging, cutting, bending, setting, and tempering. From Linden Publishing:
http://www.lindenpub.com/title2.htm

ABANA -- the Artist Blacksmiths' Association of North America publishes two quarterly member magazines, The Anvil's Ring and The Hammer's Blow, with in-depth arts and blacksmithing articles, tutorials, critiques. Gallery of works of famous historical blacksmiths and ABANA members. Mailing list, list of plans, searchable supplier directory database with more than 1,000 suppliers.
http://www.abana.org/

TheForge email mailing list is maintained by ABANA, the Artist-Blacksmith's Association of North America. Subscribe online:
http://www.abana.org/
Or email: listproc@wugate.wustl.edu
Type: subscribe theforge <your name>

The **Elektric Anvil** has a set of searchable web forums, real-time Java-based chat room, extensive links page, site search and more. The Blacksmith's Compendium, a collection of mailing list postings gleaned primarily from ABANA's TheForge mailing list organized into single documents for each of a range of topics -- a good FAQ.
http://www.celticknot.com/elektric/anvil/index.html

Blacksmiths Virtual Junkyard -- "The idea here in Blacksmiths Virtual Junkyard is to carry on the blacksmith tradition of sharing ideas, sources and information with fellow blacksmiths." The JunkYard is an online blacksmiths' forum, with archive, the Sketchbook is for posting drawings, plans and information, Scrapbin for buy and sell listings -- anvils, forges, blacksmithing tools and equipment for sale, BigDogCatalog -- Frequently discussed subjects FAQ from the JunkYard forum: forges, anvils, power hammers, coal/fuel, iron/steel, flux, books, tools, safety, heat treating, bladesmithing, history. A good resource. Blacksmiths WorldWide is a directory of blacksmiths in dozens of countries ("Get in touch with smiths in Sri Lanka").
http://www.keenjunk.com/

"anvilfire" online blacksmithing and metalworkers reference has a lot of resources. FAQs and a Guru to answer questions, "Blacksmithing in the 21st Century -- An odd mix of FAQs and

Articles", planned as a book but now an online reference, a Master's Plan File -- plans, drawings and ideas from the Guru's sketchbook, video demonstrations, bookshelf, links, news, conference reports, and articles.
http://www.anvilfire.com/

The monthly **Blacksmith's Journal** features blacksmithing techniques, tools, and forged ironwork. Index of monthly designs plus Sample page showing the step-by-step, fully illustrated projects of technique and design in every issue. Large collection of high-quality original designs, with Editor/Publisher Jerry Hoffmann's clear drawings. Nine annual volumes, order by volume or by issue. Loose leaf format for easy shop use and collection of issues.
http://www.blacksmithsjournal.com/

Anvil Magazine, Voice of the Farrier and Blacksmith -- monthly magazine with articles about horseshoeing and blacksmithing. Useful collection of online articles, interviews and how-to's, back issues, resources and links, site search.
http://www.anvilmag.com/

Lytton Creek Blacksmiths -- "Simple Texas hill country blacksmiths living in the past with a T-3 netfeed." FAQs and how-to's: Basics section covers basic terminology and overview plus instructions for making a pump bellows and simple forge. Advanced section has techniques on traditional welding, cutting and splitting and more. Links, resources, books, photos.
http://www.lyttoncreek.com/

"Blacksmithing: A Manual for Use in School and Shop" by Robert Washington Selvidge and James Miller Allton, 1925, Selvidge series of instruction manuals, Manual Arts Press
Selvidge was Professor of Industrial Education, and Allton, Instructor in Forging at the University of Missouri. Full analysis of the blacksmith's trade, with instructions and line illustrations. Full text online at Cornell University's Core Historical Literature of Agriculture Library:
http://chla.mannlib.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2863914

Small iron foundry

Cupolas are vertical, air-blown coke-fired cylindrical furnaces for remelting iron or bronze. They're easy to build: basically a steel cylinder lined with fire clay and provided with an air supply.

Stewart Marshall of Marshall Machine Works Ltd. builds small cupolas. He says a 10-inch bore furnace costs less than US$200 to build and the blast can be provided by a large shop vac. One man can easily

operate it alone. It will provide 20 to 25 lbs. of molten iron every 5 minutes and will burn for up to two hours.

"Building Small Cupola Furnaces" by Stewart Marshall is a 100-page book with over 50 drawings and sketches showing how anyone can build a foundry for casting iron and bronze. Exact specifications for building very small cupolas, the whole subject of small ironfounding, is covered in thorough detail, with chapters and tips on moulding, sand preparation, refractories, building all the equipment from scratch. Also Home Foundry CD with more information. From Marshall Machine Works:
http://www.rockisland.com/~marshall/cupola.html
Order online from Lindsay Publications Inc
http://www.lindsaybks.com/bks/mcup/index.html

"The Cupola Furnace" by Edward Kirk, 1910, reprint by Lindsay Publications
The iron caster's bible. The finest historical book on cupolas. Nearly 500 pages, covers all aspects of cupola construction and operation at the turn of the century, copiously illustrated.
http://www.lindsaybks.com/bks/kirk/index.html

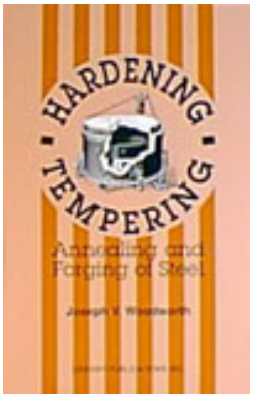
"US Navy Foundry Manual", 1958 -- This heavily illustrated how-to manual covers everything from moulding and pouring to shaking out. From Lindsay Publications:
http://www.lindsaybks.com/bks/foundry/index.html

"Practical Wood Pattern Making" by J Robert Hall -- Reprint of 1934 textbook on how to build the detailed master wooden patterns that are used to leave voids in casting sand into which molten metal is poured. From Lindsay Publications:
http://www.lindsaybks.com/bks/foundry/index.html

"Wood Pattern Making" by Herbert McCaslin, 1923, reprint 1997
How to make foundry patterns and moulds to produce castings to fabricate tools and machines. Wood pattern-making is an art -- different from other branches of woodworking. This is a text for students learning the art. Includes sections on bench work and lathe work. From Linden Publishing:
http://www.lindenpub.com/title12.htm

"Building An Inexpensive Small Scale Furnace For Melting Nonferrous Metals" by Hank Kaminsky of The Art Experience -- details for a small furnace made of fire bricks and powered by a hairdrier:
http://wuarchive.wustl.edu/edu/arts/metal/TOC/proces/cast/furnace.html

"How to Build a Forge" by David Wimberley
How to convert a standard water heater shell and old vacuum cleaner into a quality blacksmithing forge for very little money. This is a 20" diameter firebrick-lined design which requires no welding and has a hood that with careful installation will allow you to operate the forge indoors. Excellent plans. From Linden Publishing:
http://www.lindenpub.com/title2.htm



"Hardening, Tempering, Annealing and Forging of Steel" by Joseph V. Woodworth, 1907, reprint 1990
Valuable information on making, hardening and finishing all types of tools, including drills, mills, reamers, dies, countersinks, etc. Chapters include steel selection and identification, annealing processes, heating and cooling of steel, hardening, forging and welding, grinding, and more. From Linden Publishing:
http://www.lindenpub.com/title2.htm

Machining

"Build Your Own Metalworking Shop from Scrap" by Dave Gingery -- seven books: charcoal foundry, lathe, shaper, drill press, milling machine, deluxe accessories and brake. From Lindsay Publications:
http://www.lindsaybks.com/dgjp/djgbk/series/index.html

Dave Gingery's metal lathe from scrap -- 7" capacity metal cutting lathe accurate to 0.001", 12" between centres. Uses castings produced by Gingery's charcoal foundry.

"Hasluck's Metalworking Handbook" by Paul N. Hasluck, 1907, reprint Lindsay Publications
This master how-to manual covers all aspects of working metal -- 760 pages and 2,206 illustrations covering just about everything to do with metal. A lot of it just isn't taught anymore. "Foundry" covers building a Faraday blast furnace, a gas injector furnace, a brick-built furnace, an oil furnace, crucibles, flasks, sands and more. Contents: foundry work,

smiths' work, surfacing metals, polishing metals: the machines and processes, annealing, hardening, and tempering, drilling and boring, taps, screwplates, and dies, soldering, brazing and riveting, forging iron and steel, working sheet metal, repousse work, oriental decorative brasswork, finishing, lacquering, and coloring brass, lathes and lathework, spinning metals on the lathe, tools for measuring and testing metalwork, building a 4 1/2 in. centre lathe, gilding and silver working, making a skeleton clock, building a small horizontal steam engine, making a 1/4-hp vertical steam engine, boiler making, building a petrol motor, making water motors, building a dynamo and electric motor, electroplating, wire working, electric bell making, making a microscope and telescope. From Lindsay Publications: http://www.lindsaybks.com/bks/hasluck/index.html

"Advanced Machine Work" by Robert H. Smith, reprinted by Lindsay Publications
General machine shop book first published in 1915, updated in 1925 -- new enough to still be of great value, but old enough to cover many techniques that are no longer taught. Easy-to-read text, step-by-step instructions, good illustrations, very wide-ranging, detailed instructions on all aspects of machine-shop work, including making many things that are only mass-produced today. 800 pages, heavily illustrated, amazing detail. From Lindsay Publications: http://www.lindsaybks.com/bks/advmach/index.html

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Appropriate technology
Appropriate technology resources
- Agriculture resources
- Wood resources

Blacksmithing
Wood fires that fit
Houses that fit
Water-powered water pumps

Journey to Forever and AT
- Chinese watering cans
- Handmade Projects watering can plans
- Hoe for victory!
- Billhooks and sickles

A better rat trap
- Rats and owls
- Chinese rat trap
- How to make a Chinese rat trap
- Bucket rat trap

Appropriate technology subjects

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Appropriate technology resources
Agriculture resources
Wood resources
Blacksmithing
Wood fires that fit
Houses that fit
Water-powered water pumps
Journey to Forever and AT
Chinese watering cans (with plans)
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Wood fires that fit

Improved stoves
Wood-gas stoves
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Resources

Half of humanity cooks over woodfires -- the poorer half. Nearly half the world's wood supply is used as fuel.

But it's not enough -- more than 2 billion people are facing fuelwood shortages. Forests in the developing countries are shrinking by more than 15 million hectares a year. The ratio of forests-to-people is less than half what it was in 1960.

For most, there's little alternative to burning wood -- wood energy is here to stay.

In fact burning wood is no bad thing: the efficient use of wood fuel is much more eco-friendly than more efficient and convenient fuels like kerosene and natural gas (LPG). LPG emits 15 times more CO2 (carbon dioxide) per kg than wood, and kerosene nearly 10 times as much. CO2 is the main source of global warming.

And as long as wood burning is sustainable and doesn't cause deforestation, its CO2 emissions are neutral -- the CO2 released in the fire simply gets recycled back into more trees.

But at this rate it's not sustainable, and most woodfires and cooking stoves are inefficient -- they waste energy, and they pollute the atmosphere both indoors and out. Indoor smoke pollution now ranks 8th in health burden worldwide (lost years of healthy life), and ranks fourth in the "least-developed" countries (which make up about 40% of the world population) according to the World Health Organization's **World Health Report 2002**.
http://www.who.int/whr/en

"**Smoke gets in their eyes**" -- Independent research indicates that indoor air pollution is a contributory cause of around two million deaths in developing countries. Acute respiratory infections, ear and eye problems, breathlessness, chest pains, headaches and giddiness are just some of the symptoms that poor woman and children suffer in their rural homes. And the cause? Smoke from cooking. ITDG -- Intermediate Technology Development Group:
http://www.itdg.org/html/whats_new/smoke_gets_in_their_eyes_pr.htm

Full report: "**Reducing indoor air pollution in rural households in Kenya: working with communities to find solutions**", ITDG project 1998-2001, January 2002. Acrobat file, 3.4Mb
http://www.itdg.org/html/advocacy/docs/smoke_project_report.pdf

There's no single answer -- like most development and environment issues, it needs an integrated approach. Cheap, simple and effective solar box cookers have tremendous potential, but again they are only part of the solution, though an important part (see **Solar box cookers**).

Initiatives such as agroforestry for small farms (see **Farming with trees**) and people-centred forestation projects rather than industrial plantations are taking effect and have great promise (see **Trees, soil and water**).

Rural development
Fixing what's broken
City farms
Edible cities
Organic gardening
Everyone can grow their own food
Composting
The Wheel of Life
Small farms
The way forward
Biofuels
Fuel for the future
Solar box cookers
Sun power saves lives and trees
Trees, soil and water
Healthcare for mountains
Seeds of the world
No seeds, no food
Appropriate technology
What works and fits
Project vehicles
The workhorses

Internet
Why it really matters
Internet interaction
Finding your way

Schools projects
Introduction
Biofuels
Solar box cookers
Backpack stove
PicoTurbine
Low-tech radio
What to do with a cardboard carton
Sisters of silk
Silkworms in a shoebox
School gardens
School composting
Trees and forests
The Beach House fish pond
HOMeR
Eco-footprint

The forestation projects that work best are the grassroots-level projects that involve local communites at every level. When they're in control, local people maintain the forests they depend on, and the main thing they depend on them for is usually firewood -- one reason alternative fuels may not always be a good idea.

But it is a good idea to find better ways of burning the wood. One answer is better wood-burning stoves.

Improved stoves

In Kerala, India, more than half a million homes now have Parishad ovens -- high-efficiency wood burning stoves which use at least 50% less firewood, saving 0.6-0.8 million tons of firewood a year.

Improved stoves save fuel and cut health-damaging indoor smoke pollution. Almost every country in Asia has its own improved cook stoves program. In 15 years India's program has distributed nearly 30 million improved chulha clay stoves to rural and semi-urban households (with 90 million households to go). Each new stove can save the equivalent of 210 kg of coal/soft coke a year, or 40 litres of kerosene, a huge overall saving.

"Improved Solid Biomass Burning Cookstoves: A Development Manual" by Prof. S.K. Sharma, Director of the Energy Research Centre of Punjab University, Field Document No. 44, 1993, FAO Regional Wood Energy Development Program in Asia

Improved chulha stove in India (FAO)

Basic information on the development and dissemination of improved cookstoves, for field workers and others. 125-page manual covers History, Principles of Improved Cookstove Design and Development, Wood and Biomass, Improved Cookstove Technologies, Environmental and Health Implications, The Kitchen, Improved Cookstoves as Combined Technology, Future Needs, Bibliography and Appendix (Chimneys).
http://www.rwedp.org/fd44.html

Download the manual (Acrobat file, 943kb):
http://www.rwedp.org/acrobat/fd44.pdf

Mirte improved stoves in Ethiopia halve wood consumption and vacate the smoke (Mike Bess, Energy for Sustainable Development, UK)

The thermal efficiency of the improved stoves is 25-35%, compared to only 6-10% for traditional stoves. But even the improved stoves aren't very efficient -- they could be up to three times more efficient, saving an enormous amount of energy (trees), and cutting pollution and greenhouse gas emissions at the same time, with big savings for poor households.

"It is not impossible to have a biomass cook stove with total combustion and an approachable efficiency of around 65%, and also made available at an affordable cost," says Prof. P.D. Grover of the Indian Institute of Technology in Delhi. He says a **"Dream Stove"** would cost from US$8-12, or less with mass production and the use of local materials. See "Cost Estimates For A 'Dream Stove' For Asia":
http://www.ikweb.com/enuff/public_html/Dream/paper-grover.htm

School and youth programs on the Web
Education resources on the Web
Children's poetry

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Ichijima
Japan

Biomass Cooking Stoves page -- by "stover" Alex English, one of many working to improve stove technology:
http://www.ikweb.com/enuff/public_html/Stoves.html

Improved Cookstoves and Charcoal Production -- "The Appropriate Technology Sourcebook: A Guide to Practical Books for Small Community Technology" by Ken Darrow and Mike Saxenian, revised and enlarged edition, 1993, Consortium for Sustainable Village Based Development (CSVBD) ISBN 0917704185. This section of the Sourcebook has reviews of 37 books on improved cookstoves and charcoal production covering all aspects of the subject from design to community acceptance, along with a concise but thorough 1,000-word overview of the problems, constraints and solutions. It includes some wise cautions. For instance, you might assume that the less smoke the better, but you might be wrong: "In many places, smoke from indoor cooking fires is a significant contributor to lung and eye disease. Yet this smoke also serves to dry crops hung over the cooking area and to protect thatched roofs from insect damage" -- a classic pitfall for the unwary development worker. It's best to assume that your assumptions will be wrong. The reviews are pithy and to-the-point, with sources for the books and prices. Reading the whole section (about 8,000 words) will give you an excellent introduction to this highly promising but far from simple field of work. Online at publishers Village Earth/CSVBD:
http://www.villageearth.org/atnetwork/atsourcebook/index.htm

Appropriate Technology Library: AT Library Disk #14: Energy: General and Energy: Cookstoves -- A Woodstove Compendium. Covers wood-burning cookstove design and construction, testing procedures, evaluating fuel consumption, charcoal making, different fuels, and much more.
http://www.villageearth.org/Merchant2/merchant.mv?Screen=PROD&Store_Code=ATL&Product_Code=ATL14&Category_Code=98675

Appropriate Technology Library: AT Library Disk #15: Energy: Cookstoves Cont. & Energy: Wind -- Improved Stoves, Comparisons, indoor smoke pollution, Splitting Firewood, Markets, Testing Timber for Moisture, Improved Pit-Kiln for Charcoal, the Jiko, and more.
http://www.villageearth.org/Merchant2/merchant.mv?Screen=PROD&Store_Code=ATL&Product_Code=ATL15&Category_Code=98675

"Cookstoves for the Developing World" by Daniel M. Kammen of Princeton University, Scientific American, 1995 -- "Traditional wood, charcoal and coal stoves are used in hundreds of millions of homes. Their redesign can have a dramatic effect on energy usage, the environment and community health." Good overview.
http://www.wws.princeton.edu/programs/stpp.articles/cookstoves.html

Wood-gas stoves

Wood-gas cooking stoves are perhaps the best answer so far. These are gasifiers that produce gas from wood and then burn the gas, leaving charcoal (itself a useful fuel). They're clean, fast and efficient. They burn small pieces of wood, sticks, wood chips, corncobs or nutshells, producing a clean, blue flame and no smoke. A lot of cunning engineering has gone into the development of these stoves, and yet they're easily made from locally available materials -- even tin cans.

Technically, they're called "inverted downdraft gasifier" stoves, operating on natural convection. How wood-gas stoves work: "A Wood-gas Stove For Developing Countries",

Swosthee wood-gas stoves in Malaysia

by Tom B. Reed and Ronal Larson, Biomass Energy Foundation. 300g of sticks or chips burn for 30-45 minutes at high efficiency with low emissions.
http://www.ikweb.com/enuff/public_html/T1.htm

Wood Gas -- The Biomass Energy Foundation's Home Page
http://www.woodgas.com/

Richard Boyt's low-tech wood-gas stove, made from 10 tin cans

The **"Turbo"** is a wood-gas, adjustable heat, cooking stove that burns small pieces of wood or other biomass fuels such as nut shells, corn cobs, etc. An extremely clean burning stove that can be used indoors with only minimal ventilation and cooks as fast as a modern gas or electric stove. It can boil 500 ml of water in 3.5 minutes, comparable to an electric or gas stove. It uses a 3 Watt blower and develops 3 kilowatts of heat.

http://www.ikweb.com/enuff/public_html/Turbo/Turbo.htm

http://www.ikweb.com/enuff/public_html/Turbo/Turbo2.htm

We made a prototype wood-gas stove out of two 400g tomato cans. One had lots of holes punched in the bottom and a sort of slider affair to control the air supply; the second can had no bottom and fitted on top of the first can, with a small gap. We filled the bottom can with small bits of wood, stacked upright, lit it with some tinder on top and put the second can on. The fire immediately stopped smoking and produced a clean, hot gas flame. It burned for half an hour, and left us with a pile of nice charcoal sticks.

We don't know how else you'd get so little wood -- only 120 grams (4 ounces) -- to burn that long and that hot, and leave you with a fuel supply in the end..

For comparison we made an ordinary fire with the same amount of wood. It burned for only 10 minutes, smoked a lot, and left some unreusable ash and coals. Then we tried the charcoal from the stove: it burned nicely for 25 minutes without any smoke, leaving a small pile of ash. These stoves really work! -- 10 minutes of a smoky, flaming, energy-wasting wood fire, vs 55 minutes with stove and charcoal, no smoke, and much less residue.

We've made a much better stove now, though it's still far from perfect -- see **Cookstoves for schools**.

Aprovecho Research Center -- **Latin American Stove Project**, home of the Rocket Stove
http://www.efn.org/~apro/attitlepage.html

Stoves Mailing List
Subscribe: stoves-subscribe@crest.org
Unsubscribe: stoves-unsubscribe@crest.org
Post message: stoves@crest.org
Stoves List Archives and Website:
http://www.crest.org/discussiongroups/

Other simple and effective stoves:

The Hobo Stove
TrailStove
Volcano kettle
Backpack stove

Volcano kettle

Scott Henderson's **Pepsi Stove**
http://wings.interfree.it/html/Pepsi.html

The Home Made Stove Archives
http://wings.interfree.it/index.html

SuperShioshio lives in Yokohama in Japan, he's a mountaineer and he collects backpack camping stoves. "I seem to be attacked by stoves," he says -- he has more than 200 of them, stoves of every possible type, all on display at his website.
http://www.asahi-net.or.jp/~we2a-sod/index.htm

Charcoal

Charcoal is second only to wood as a Third World fuel. It's half the price of kerosene, a quarter the price of LPG or electric power. It burns without smoke, stores well without rotting, for the producers it's much lighter than wood and easier to transport, and producing it keeps many thousands in work. And it's a high-energy fuel -- ideal for local blacksmiths' forges and for small industry.

But it's a very wasteful fuel -- cooking with charcoal uses much more wood than cooking with firewood. Burning wood to make charcoal wastes a lot of energy and creates a lot of pollution, and most Third World charcoal production is inefficient.

Traditional charcoal kiln (RWEDP)

Like firewood, the demand for charcoal is growing, and cannot be stopped. Again, there are tremendous savings to be made with more efficient cooking stoves, and also by improving the efficiency of charcoal production.

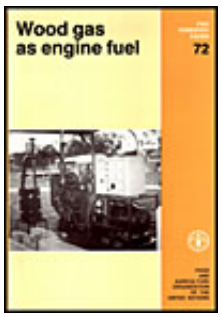
See "Burning Charcoal Issues", Robert van der Plas, The World Bank Group, FPD Energy Note No. 1, April 1995
http://www.worldbank.org/html/fpd/energy/energynotes/energy01.html

Over 300,000 Lakech improved charcoal stoves have been sold in Ethiopia -- 35% efficiency improvement at US$1 each (Mike Bess, Energy for Sustainable Development, UK)

Wood gas

The Gengas Page -- Fuel gas, produced by the

reduction of coal and peat, was used for heating as early as 1840 in Europe, and by 1884 it had been adapted to fuel engines in England. Petroleum shortages during World War II led to widespread gas generator applications in the transportation industries of Western Europe. (Charcoal-burning taxis, a related application, were still common in Korea as late as 1970.) This report attempts to preserve the knowledge about wood gasification as put into practical use during World War II. Detailed, step-by-step procedures are presented in this report for constructing a simplified version of the World War II, Imbert wood gas generator. Full text online.
http://www.gengas.nu/byggbes/index.shtml



Wood gas as engine fuel, Mechanical Wood Products Branch, Forest Industries Division, FAO Forestry Department, 1986, ISBN 92-5-102436-7
The harmful effect of high and rising oil prices on the economies and development efforts of oil-importing developing countries have become apparent. There has, as a result been increased interest in indigenous, renewable energy sources, of which biomass in the form of wood or agricultural residues is the most readily available in many developing countries. In many developing countries -- in particular in rural areas -- internal combustion engines are widely used in stationary applications such as electric power generation and operation of water pumps and mills. Technologies such as gasification, which allow utilization of biomass fuel in such engines after minimum preparation, are therefore of particular importance. A summary of modern wood gasification technology and the economics of its application to internal combustion engines. Full; text online.
http://www.fao.org/DOCREP/T0512E/T0512e00.htm

The making of the Källe-gasifier by Torsten Källe, Royal Swedish Academy of Engineering, 1942 (Translation to English 2000, Joacim Persson -- Torsten Källe's charcoal gasifier was somewhat ahead of its time. It was very popular due to its easy maintenance and fuel economy. Some features of this gasifier are perhaps recognised in modern gasification technology; among many things it was a sort of predecessor to what today is called 'circulating fluidised bed.' Charcoal gasifiers were generally more popular than wood gasifiers during the producer gas era in Sweden in the days of WW2, even as the wood gasifiers improved in design. Wood gas was cheaper, but charcoal gasifiers were so much easier to handle.
http://www.hotel.ymex.net/~s-20222/gengas/kg_eng.html

The Woodfired Gas Producer -- the Australian woodgas odyssey: "We reckoned on about 2,000 km per tonne of wood (2km/kg). This should be improved by the addition of steam to an expected 2,500-3,000 km per tonne. The amount of water used is about the same as the gallonage of petrol that would be consumed." Detailed description, with drawings. http://members.tripod.com/~highforest/woodgas/woodfired.html

Alternatives to Fossil Fueled Engine/Generators, by Clifford W. Mossberg -- Woodgas for engines and for power -- From Homepower Magazine. Acrobat file, 176kb
http://ww2.green-trust.org:8383/woodgas.pdf

History of Woodgas, by Tom Reed of the Biomass Energy Foundation
http://www.woodgas.com/History.htm

Woodgas Powered VW's and Other Vehicles

http://www2.whidbey.net/lighthook/woodgas.htm

Wood Heat -- the Wood Gas page at Renewable Energy Resources: "Provided harvesting is conducted in a sustainable manner, the combustion of wood for energy production is essentially carbon dioxide-neutral when the normal forest regeneration period is considered. When wood combustion replaces the consumption of fossil fuels, however, the net reduction in carbon dioxide release is almost immediate."
http://ww2.green-trust.org:8383/wood_heat.htm

Electricity from wood waste (links) -- The Wood (Producer) Gas page at Renewable Energy Resources: "Gasification is the cleanest, most efficient combustion method known. It has been used for decades where clean heat is required. Examples include the thousands of vehicles which were directly fuelled by Gasifiers during the Second World War, or the coal gas 'works' which were common in cities all over the World before natural gas. These produced gas which combusted so clean it was used in chimney-less household appliances such as cookers and heaters, without adverse effects. New technology is opening up the prospect of utilizing wood waste from forest harvesting and sawmills for efficient, small-scale electricity production. Potential benefits include worthwhile cost savings as well as the 'greenhouse-friendly' replacement of fossil fuels with a renewable energy source."
http://ww2.green-trust.org:8383/woodgas.htm

Resources

"Growing Demand for Wood Energy" -- FAO Regional Wood Energy Development Program in Asia (RWEDP):
http://www.rwedp.org/

The RWEDP's **Wood Energy Database** is one of the best online resources on wood energy issues. Data are grouped in five main categories -- Resources: Land use, Wood resources, Wood production, Wood residues, Crop production, Crop residues; Utilization: Consumption; Woodfuel Flows: Woodfuel Sources, Employment, Prices; Socio-economic: Population, Economy, Health, Gender. Synopses and TOCs online, linked to documents for downloading (most in Acrobat format).
http://www.rwedp.org/d_database.html

No Substitution of Traditional Fuels
http://www.rwedp.org/p_nosubst.html

Increasing Use of Wood Energy
http://www.rwedp.org/increase.html

Woodfuel Emissions
http://www.rwedp.org/p_weground.html

Energy and Environment Basics
http://www.rwedp.org/rm29.html

Woodfuel in Pakistan
http://www.rwedp.org/fd51.html

Wood-based Energy Systems for Rural Industries and Village Applications -- Bangladesh
http://www.rwedp.org/rm34.html

Wood-Based Energy Systems for Rural Industries and Village Applications -- Pakistan
http://www.rwedp.org/rm31.html

Charcoal and its Socio-Economic Importance in Asia: Prospects for Promotion
http://www.rwedp.org/p_charcsocio.html

Women in Wood Energy Development
http://www.rwedp.org/rm24.html

Gender and Wood Energy in Asia
http://www.rwedp.org/rm22.html

Improved Cook Stove Programs -- Some lessons from Asia
http://www.rwedp.org/p_stoves.html

Indian Improved Cookstoves: A Compendium
http://www.rwedp.org/fd41.html

Chinese Fuel Saving Stoves: A Compendium
http://www.rwedp.org/fd40.html

Can a small NGO match a huge multinational oil company when it comes to reducing greenhouse gas emissions? Dr. W.S. Hulscher, Chief Technical Adviser for the Regional Wood Energy Development Program in Asia (RWEDP), compares the effects of a local NGO distributing 15,000 improved wood and charcoal stoves a year in Laos with the potential of a large production facility for photovoltaic solar energy panels built by Shell in Europe -- with surprising results: they're equal. "Solar electricity is 1,000 times more expensive than cooking on wood," he adds. See "The Battle in the Greenhouse":
http://www.rwedp.org/p_ngoshell.html

Intermediate Technology Development Group books and manuals on fuel-saving cookstoves:

Biomass Stoves -- Samuel F Baldwin.
http://www.developmentbookshop.com/book.phtml?isbn=0866192743

Modern Stoves for All -- Waclaw Micuta.
http://www.developmentbookshop.com/book.phtml?isbn=0946688354

Improved Wood Waste and Charcoal Burning Stoves: A practitioners manual
http://www.developmentbookshop.com/book.phtml?isbn=0946688656

The Kenya Ceramic Jiko: A manual for stovemakers -- Hugh Allen.
http://www.developmentbookshop.com/book.phtml?isbn=1853390836

Stove Maker, Stove User: Fuel-efficient stoves in Sri Lanka -- Val Rea and Mike Martin
http://www.developmentbookshop.com/book.phtml?isbn=1853390992

How to Make and Use the Upesi Stove: Guidelines for small businesses -- Vivienne Abbott, Clare Heyting and Rose Akinyi
http://www.developmentbookshop.com/book.phtml?isbn=9966960600

Appropriate Mud Stoves in East Africa -- Stephen Gitonga
http://www.developmentbookshop.com/book.phtml?isbn=9966960643

"Portable Metallic Cookstoves", Industry Profile #12, Understanding Technology Series, Volunteers in Technical Assistance (VITA), 1988, ISBN 0-86619-299-9
Guide for local artisans or small-scale local industries to manufacture a wood-saving, money-saving, wood-burning cookstove which uses a small amount of wood and cooks rapidly. Reduces wood use and cooking times by about half. Can be made from new or recycled sheet steel (such as cut-up oil drums) by anyone with a hammer and chisel. Designed to reduce the use of fuelwood in response to deforestation of such areas as the West African Sahel.
http://www.vita.org/publications/industry.htm

"Come home to wood heat, it's good for you." The **Wood Heat Organization** is a non-profit NGO dedicated to the responsible use of wood as a home heating fuel. Incorporated in Canada and still with a North American focus, its objective is to provide useful information to anyone who uses wood for home heating, wherever in the world they live. "Wood is an effective, renewable energy source for household heating and cooking when sustainable forestry methods are used for fuel supply and when the fuel is burned using appropriate technologies and techniques." Why heat with wood? -- woodburning technologies -- hearths -- chimneys -- firewood -- safety -- tips and techniques -- environment -- lore.
http://www.woodheat.org/index.htm

"Top down fever -- a new (old) fire-building technique": the top-down technique is the counter-intuitive opposite of the usual way of building fires, but it works, and works better, with much less smoke.
http://www.woodheat.org/tips/topdown.htm

"Fuel For The Fires: Charcoal Making in the Nineteenth Century", Chronicle of the Early American Industries Association (June, 1994).
http://www.connerprairie.org/fuel.html

How to make charcoal at home -- using a 55-gallon oil drum: full instructions, with further information and links.
http://www.velvitoil.com/Charmake.htm

Making your own charcoal -- simple step-by-step instructions with diagrams using an oil drum.
http://www.eaglequest.com/~bbq/charcoal/index.html

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Appropriate technology resources
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- Wood resources

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Wood fires that fit
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Cookstoves for schools

Putting 50 billion throw-away chopsticks a year to better use

We've been working on developing a small inverted downdraft gasifier woodstove for a schools project, initially in Japan, but good for anywhere. We've made four prototypes so far: they work, but they're not perfect, not good enough for a schools project. We could use some help!

Picture 1 -- Prototype #4

See **Wood fires that fit**
Wood-gas stoves

Background

Japan makes itself unpopular worldwide by throwing away 130 million pairs of disposable wooden chopsticks per DAY!!! -- made out of other people's forests, not their own. Some countries are being seriously deforested because of Japan's throw-away chopsticks. The Japanese are not unaware of the problem, but not a lot gets done, beyond tokenism (such as a disposable chopsticks wrapper from one of the ubiquitous convenience stores, bafflingly labelled "Ecology Earth Effort").

Some of the schools are aware of the problem -- some don't use disposable chopsticks, some even collect them and do things with them -- one enterprising school turns them into paper and makes postcards out of them.

We propose burning them in an improved cookstove. Preferably it should be a stove that a school class could make in a few hours, preferably out of "tincanium" (millions of waste tin cans in Japan, they get recycled but it's a good part of the lesson) -- but this isn't essential, it's more important to have a design that works well. If too difficult for a class to make, it could perhaps be supplied in kit form. Mainly it has to work without fail, and without gassing everybody while cooking the rice for a school lunch.

It's not that long ago that everyone still cooked with charcoal, so to get TWO cookings out of a handful of chopsticks, one with the chopsticks, the other with the charcoal, has a lot of lesson potential. The lesson about how such stoves can improve lives in the Third World, and the conditions there, along with the obvious lesson of

the disposable chopsticks themselves, should make it a worthwhile schools project.

Work so far

Picture 2 -- secondary air is pre-heated by the fire, around the sides and through the centre pipe.

We used Tom Reed's basic two-coffee-cans design as a starting point, but scaled down. See **"A Wood-gas Stove For Developing Countries"**, T. B. Reed and Ronal Larson
http://www.ikweb.com/enuff/public_html/T1.htm

We're still not sure whether such stove designs can be scaled down effectively this way, but this first design was beginner's luck -- very rough-and-ready, just to see if we could do it, but it worked surprisingly well.

It was made out of two 400g tomato cans, one with lots of holes punched in the bottom and a primitive slider to control the air supply, the second can with bottom removed and fitted on top of the first can, with a small gap. It burned for half an hour, and left us with a nice pile of charcoal sticks.

Picture 3 -- The lever next to the leg on the left controls the primary air-supply. The rim of the inner can is 0.8cm below the outer can rim; the top of the centre-pipe is flush with the inner-can rim.

The second attempt didn't work as well, nor did the third. The stoves were difficult to light, they kept going out, when they did condescend to burn they smoked a lot and stank, and obviously had air-supply problems.

I shut off the primary air-supply at the bottom of the third stove, connecting a shallow can under the stove, airtight, and led in an air-supply from a fishtank aerator pump -- not a great deal of air, but it made all the difference: the stove worked much better with the pump than without it.

But we didn't want to use a pump or a powered fan -- a stand-alone stove without any externals would be far better, if we could only get it to work properly.

I was thinking of insulating the stove with a papercrete mixture, but then decided instead to try harnessing the waste heat to warm the secondary air-supply, which seemed to be the main problem. This involved putting the bottom can inside a somewhat bigger can, with the secondary air-supply coming up from the

bottom, to be warmed by the heat of the fire in the inner can. I also put a half-inch copper pipe up through the centre of the can, also supplied with air from underneath, as an additional secondary air-supply, also heated by the fire. This seemed more hopeful. The top can fitted into the lid of the outer can below, containing the secondary air supply from below.

This stove works much better. It certainly burns well -- rather too well: flames roar up much higher than the rim of the top can. It takes 50 pairs of chopsticks, cut in half, weight 200 grams, standing vertically. It burns for 25 minutes to half an hour, and will boil half a litre of water from 15 deg C in four minutes. It leaves 20-25 grams of charcoal.

Pictures 8-9 -- Secondary air via the centre-pipe and round the sides is independent of primary air-supply.

But it smokes a bit, sporadically, obviously tars and CO are being released -- not healthy. The flame is yellow-orange, tinged with blue. The jet from the centre pipe seems to work best, with more of a blue flame mingling with the yellow-orange from the heated air coming in from round the side. It seems to work rather better as the fire progresses down the can towards the bottom. Near the bottom it works really well.

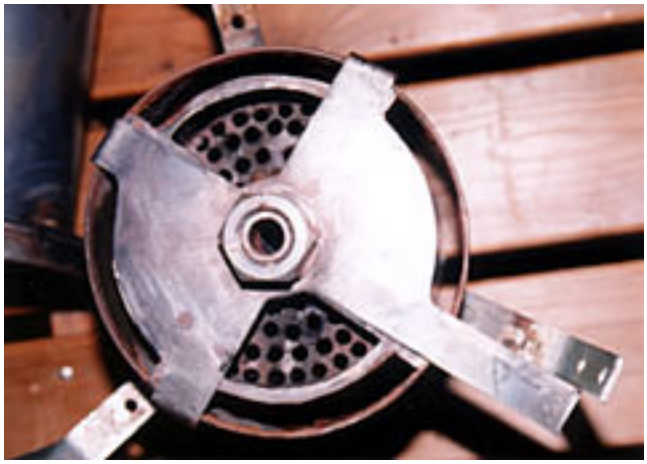
One parameter is the size of chopsticks -- 18-21 cm long. A stove that took full-sized chopsticks might be rather big, though that could be the way to go. So far we've worked with half-size: the burner can has about 1cm under the grille and allows for 9-10.5cm wood standing upright with 1cm clear below the rim -- overall height 12.5cm, diameter 9cm.

I tried using a wick, inserting a smaller can into the top can, but didn't get anywhere with it, it didn't work at all.

Any advice would be very welcome indeed! Please send suggestions/comments to: keith@journeytoforever.org

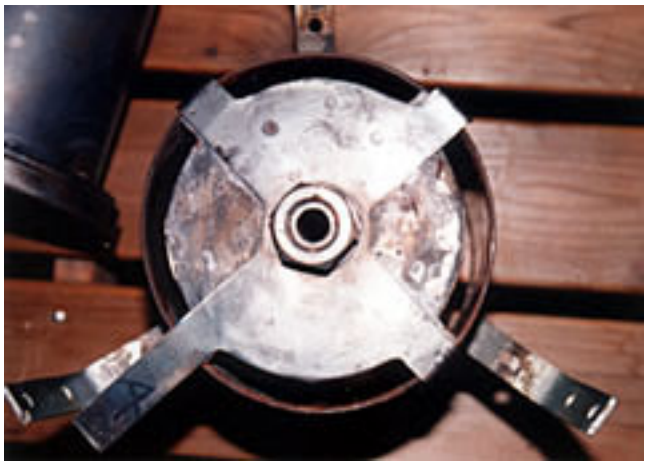
Keith Addison
Journey to Forever
Handmade Projects
Tokyo

Picture 4 -- Secondary air via the centre-pipe and round the sides, primary air is controlled by the slider.



Picture 5 -- Primary air-supply set wide open.

Picture 6 -- Primary air-supply half-open.



Picture 7 -- Primary air-supply closed.

Global wood

David Morris of the Institute for Local Self-Reliance wrote: "A few years ago I was eating at a St. Paul restaurant. After lunch I picked up a toothpick wrapped in plastic. On the plastic was printed the word, 'Japan.' Now Japan has little wood and no oil. Nevertheless it has become efficient enough in our global economy to bring little pieces of wood and barrels of oil to Japan, wrap the one in the other and send them to Minnesota. This toothpick may have traveled 50,000 miles. But never fear, we are retaliating in kind. A Hibbing, Minnesota factory now produces a billion disposable chopsticks a year for sale in Japan. In my mind's eye I see two ships passing one another in the northern Pacific. One carries little pieces of Minnesota wood bound for Japan; the other carries little pieces of Japanese wood bound for Minnesota. Such is the logic of free trade."

In Tokyo we came across a discarded NASA emergency survival kit, unopened. It contained some crackers and sweets, a small chemical stove, a can-opener (you've no idea how thrilled we are to have a genuine NASA can-opener), and an old-fashioned wooden box of waterproof matches, so labelled in three languages, with the legend: "Made in Australia, distributed by Coghlan's Ltd, Winnipeg, Canada". (See Exhibit A, *right*.) Did they take the wood from the Canadian forests to relatively forest-free Australia so they could make the matches there, and then ship them back to Canada for packaging, and then to Tokyo, via NASA? At a profit, yet? What did they use, a Space Shuttle?

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Home

Houses that fit

A straw bale house is very green and "ecological". Or maybe it's not: maybe it would be even more green and ecological to compost the straw and use the compost to help rejuvenate the depleted soil the straw came from.

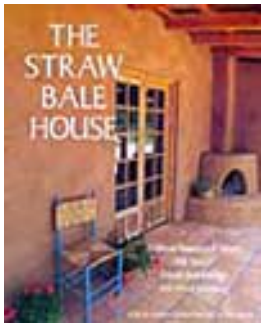
Or it might be better to mix the straw with clay to make bricks. But baking bricks means burning lots of wood in a kiln -- fine if there's plenty of wood (and it's an efficient kiln). And bricks then need cement to stick them together -- too expensive for many, and making cement needs high temperatures and a lot of energy.

If you live near a volcano, you could mix volcanic ash with lime to make a cheap, strong cement that doesn't need heating.

If not, it might be better to use the clay to make an adobe (mud) house and use the straw to thatch the roof.

Or make a clay roof, fill the house with the straw and burn it to bake the clay -- then you'll have a weatherproof ceramic house.

Which is best? It all depends.



"The Straw Bale House" by David Bainbridge, 1994
How to build a well insulated, sturdy, beautiful house using straw bales as the building blocks. Details, plans and photographs. From Chelsea Green:
http://www.chelseagreen.com/StrawBale/StrawBale.htm

"Build it with Bales -- Version Two: A Step-by-Step Guide to Straw-Bale Construction" by Matts Myhrman & S.O. MacDonald, 1997, Out on Bale, ISBN 0-9642821-1-9
Starting with bales, three basic approaches, developing a plan, the loadbearing option, the non-loadbearing option, surfacing the walls. Over 100 illustrations, bibliography. From Chelsea Green:
http://www.chelseagreen.com/DP/BuildBales.htm

"House of Straw -- Straw Bale Construction Comes of Age", Energy Efficiency and Renewable Energy (EREN), US Department of Energy.
Construction techniques discussed in this booklet focus on building

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Introduction
Biofuels

resource-efficient and energy-conserving homes, without sacrificing affordability or quality. In a cooperative demonstration project between the US Department of Energy, the U. Department of Housing and Urban Development, and the Navajo Nation, current home designs on the Navajo reservation were evaluated and recommendations were made to improve quality and lower the costs. The resulting design utilized straw-bale wall construction. 8,000-word illustrated booklet, online.
http://www.eren.doe.gov/buildings/documents/strawbale.html

Straw Bale Construction -- Sustainable Building Sourcebook, from the City of Austin's Green Building Program. 2,250-word online resource: Definition, Considerations, Commercial Status, Implementation Issues, Guidelines, Resources: Professional Assistance, Components / Materials / Systems, General Assistance, Internet Resources
http://www.greenbuilder.com/sourcebook/strawbale.html

Surfin' StrawBale -- large collection of strawbale building links and resources.
http://mha-net.org/html/sblinks.htm

The Last Straw Journal -- "In quarterly publication since 1993, The Last Straw Journal is the subscriber-supported, reader-written international grassroots journal of straw bale construction and natural building, providing up-to-date news, inspiration, and information on techniques, projects, issues, materials, and more." (It ain't free.)
http://www.strawhomes.com/
Some free articles available online in the back issue index:
http://www.strawhomes.com/backissues.html

Strawbale Construction email discussion group:
To Subscribe: strawbale-subscribe@crest.org
Online archive for Strawbale Construction discussion group (searchable):
http://www.crest.org/discussiongroups/index.html

For composting, see our **Composting pages** -- composting is a technology that's infinitely adaptable and almost always appropriate, but that doesn't mean you must always compost everything.

Peasants in India, and elsewhere, often use cattle dung for fuel. Agricultural scientist Sir Albert Howard, the man who first developed scientific composting, was looking for a way for the

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Eco-footprint

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Education resources on the Web
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Contact us

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keith@journeytoforever.org
To Midori Hiraga
midori@journeytoforever.org
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Handmade Projects
Ichijima
Japan

peasants to extend the small amount of manure left over for use as fertilizer. Compost extends manure by four times, and is much more effective than pure manure. It meant the peasants could have it both ways.

Southern African tribes use cattle dung to make floors for their huts -- very nice floors, a bit like cork.

Fired Clay Bricks -- A New Technique for Production
http://www.idrc.ca/nayudamma/brique_56e.html

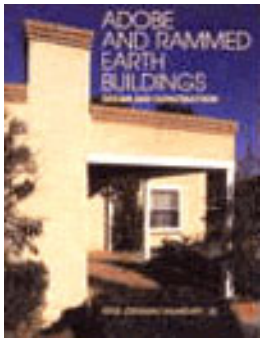
Cement Made with Volcanic Ash
http://www.idrc.ca/nayudamma/cement_58e.html

Charmaine R Taylor's **Dirt Cheap Builder** -- This is the place for books, resources, information on alternative building. 300+ books and videos for dirt-cheap housebuilding: Building With Lime, Cob & Earthen, Cordwood & Timberframe, Design Your Home, Dirt Cheap Houses & Papercrete, Heat: Stoves & Ovens, Off the Grid Homesteading, Practical: Roof, Floor, Plumb, Wire, Greywater, Small Projects, Solar Cooking, Stone Houses & Walls, Straw Bale & Light Straw Clay, and more.
http://store.yahoo.com/dirtcheapbuilderbooks/index.html

"All About Lime: A Basic Information Guide for Natural Building" by Charmaine R. Taylor, Taylor Publishing.
Answers many questions on lime and gypsum -- when to use each, how to make a natural cement, dry up mud on the worksite, and stabilize soil for earthen bricks (for Cinva Ram block presses and others). Lime is an amazing, very versatile building material which can be used on the ground, foundation, walls; for plasters, mortars, cements, garden and land tilth, and in the waste/septic systems. Chapters on plaster and mortar give recipes and current recommendations on application and use, an interview with professional straw bale plasterers, a history of how lime was used for building, and how it can be used again for an earth friendly alterative to Portland cement. Resources, bibliography, photographs, technical articles. From Dirt Cheap Builder:
http://store.yahoo.com/dirtcheapbuilderbooks/allaboutlime.html

"Building With Lime: A Practical Introduction" by Stafford Holmes and Michael Wingate, 1997, Intermediate Technology; ISBN 1853393843
Extensive handbook for construction uses of lime

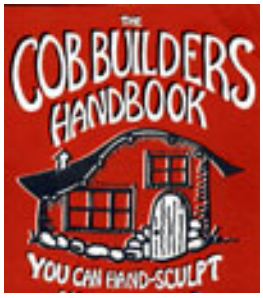
for floors, washes, wattle & daub, plasters, moldings, mortars and more. Clearly presented technical information, tests, and drawings. 312 pages, many b/w photos, illustrations. Great 'how to' book, solid reference. From Dirt Cheap Builder:
http://store.yahoo.com/dirtcheapbuilderbooks/builwitlim.html



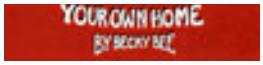
"Adobe and Rammed Earth Buildings -- Design and Construction" by Paul Graham McHenry, 1984, Reprint edition 1989, University of Arizona Press, ISBN 0816511241
Adobe and rammed earth buildings are cheap, environmentally friendly and can last for ages. This is a technical manual written to provide information for professionals. Alternative design details to meet all situations and climates. Detailed information, diagrams and photographs, in-depth design considerations. Essential guide for anyone serious about building with adobe. From Dirt Cheap Builder:
http://store.yahoo.com/dirtcheapbuilderbooks/adandramearb.html

"Understanding Adobe" by Balla Sidibe, Technical Paper # 24, Understanding Technology Series, Volunteers In Technical Assistance (VITA) -- Practical information on the use of adobe in block making in developing countries.
http://www.vita.org/publications/technology.htm

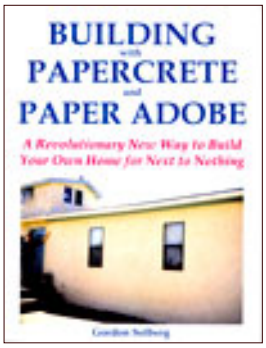
Builder's Resource & Web Guide, Taylor Publishing -- Features hundreds of amazing, obscure and hard to find information sites. From how to make casein (milk) paints, to building sod roofs, and glorious photos of alternative owner-built houses showing cob, strawbale, earthships and more. SIX other resource guides included: Workshops, People, Publications, Primary Contacts, Email groups, Video resources. Files are in MS Word for PC or Mac. "It's like having a natural building library right on your desktop!" -- Karen K., CA. From Dirt Cheap Builder:
http://store.yahoo.com/dirtcheapbuilderbooks/builreswebgu.html



"Cob Builders Handbook: You Can Hand-Sculpt Your Own Home" by Becky Bee, 1997, Chelsea Green, ISBN 0965908208
One-third of the world's population lives in homes made of unbaked earth -- "cob". Fifty thousand cob buildings are still in use in England today, most of them built in the 18th and 19th



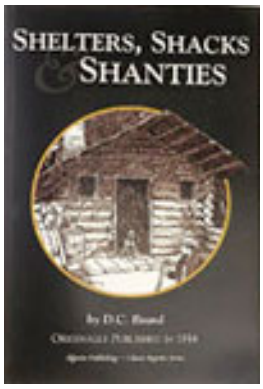
centuries. Not a fad or craze, cob is a building technique that has stood the test of time. Cob building is environmentally friendly, and it's easy -- cob is a flexible and forgiving medium. Earth, sand and straw are mixed together and massaged onto the foundation, creating thick load-bearing walls. It's like hand-sculpting a giant pot to live in. A cob house costs as little as one-sixth of a conventional house, and it's comfortable, warm in winter, cool in summer, and the walls muffle sound. Cob houses are long-lasting -- and no, they don't dissolve in the first downpour. Becky Bee has built them in the US, Australia, New Zealand, Central America, and Samoa. All the necessary basics on design, site selection, making and using cobs. Written for people with or without building experience. With 200 illustrations & bibliography. From Chelsea Green:
http://www.chelseagreen.com/DP/CobBuildersHandbook.htm
From Powell's Books:
http://www.powells.com/biblio/126800-127000/0965908208.html



"Building with Papercrete and Paper Adobe" by Gordon Solberg, 1999, Remedial Planet, ISBN 1928627005
Build a home for next to nothing -- and do some recycling at the same time. Papercrete is made of recycled paper or cardboard, sand, and Portland cement. It's strong, light, a good insulator and very cheap, you can mould it in any shape (like papier maché), it doesn't go mouldy, swell or burn. Paper adobe is even cheaper -- it's made of earth and paper or cardboard. Papercrete isn't new -- it was patented in 1928 but was too cheap to market at a profit. Now people are building homes with it, for as little as US$1 per square foot, or even less. This book tells it all with easy-to-understand text, photos, and resource information. From the Papercrete site:
http://www.zianet.com/papercrete/book.html
Papercrete News:
http://www.zianet.com/papercrete/index.html

"All About Papercrete" by Charmaine Taylor, Taylor Publishing.
Read about the latest three "inventors" working with papercrete, and how individuals are experimenting and building. Mixing instructions and formulas, descriptions for mixer construction and alternative options. Also covers building experiments with woodchips, sawdust, peat moss, hemp, lime, weeds, EPS and paper adobe, which can be used just like papercrete. NOT a housebuilding how-to , but gets you started on

construction ideas. Photos and illustrations, tips and advice, interviews and comments. Includes floppy disk with color photos, sites and more papercrete information. From Dirt Cheap Builder: http://store.yahoo.com/dirtcheapbuilderbooks/allabpap2.html



"Shelters, Shacks & Shanties" by D.C. Beard, 1914, Classic Reprint Series.
A bestseller solely on breadth of material and Beard's skilful illustrations, but his optimistic writing style also made readers feel that not only could they build the structures illustrated but that it would be a pleasure doing it. The range covers a near endless variety of structures from a hogan to a log cabin, with emphasis on temporary shelters built by woodsmen. He describes how to build them in every conceivable circumstance, including in dirt banks with sod roofs, on poles over a marsh or on a floating base on a peat bog. Also covers signal towers, tree houses, food caches and notched log ladders, all in great variety. Along the way he discusses how to use an axe to achieve all of this, as well as explaining how to make a variety of doors and fittings, from straightforward catches to secret latches and locks. With 330+ illustrations. From Lee Valley Tools:
http://www.leevalley.com/

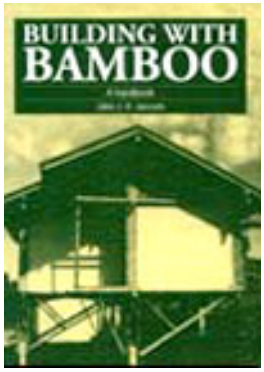
"Thatching: A Handbook" by Nicholas Hall -- great guide to good-quality thatching. How to achieve the maximum possible roof-life with either cultivated or naturally occurring materials. Easy-to-understand words and pictures. "Thatching: A Handbook" -- great guide to good-quality thatching. How to achieve the maximum possible roof-life with either cultivated or naturally occurring materials. Easy-to-understand words and pictures. From Dirt Cheap Builder:
http://shop.store.yahoo.com/dirtcheapbuilderbooks/thathan.html

"Ceramic Houses & Earth Architecture: How to Build Your Own" by Nader Khalili, 1986, 4th Edition 1996, CalEarth Press, ISBN 1-889625-01-9
Step-by-step instructions on how to construct, glaze, and fire adobe and rammed earth buildings. From Fertile Ground Books:
http://www.agribooks.com/cgi-bin/webc.cgi/~fg/st_prod.html?p_prodid=CLE001&sid=30WaMhX
From the American Ceramic Society:

http://www.ceramics.org/publications/books/bookdetails.asp?BookID=276

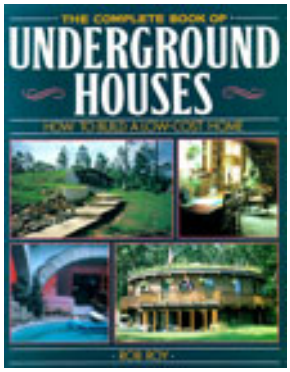
"Timber Frame Construction" by Jack Sobon and Roger Schroeder, 1984.
The book to get you started. Based on a starter project, the construction of a timber frame garden shed, it gives the history and basic principles of timber framing, describes the various joints, their uses and how to cut them, advises on design, raising and closing in, and provides all the information needed for the project and a good deal more, in precise and interesting text. Beautifully illustrated throughout with black-and-white drawings and photographs. From Lee Valley Tools:
http://www.leevalley.com/

"The Craft of Log Building" by Hermann Phleps (translated from the original German by Roger MacGregor), 1942
The definitive work on European horizontal log construction. Properties of wood, tree species, felling and seasoning, foundations and sills, log walls, cornerwork and partition wall joinery, roof framing, and everything else. Thorough treatment, well illustrated with photographs and Phleps's excellent and clear drawings. From Lee Valley Tools:
http://www.leevalley.com/



"Building With Bamboo" by Jules J. A. Janssen, 1995
This handbook brings together the practical experience of engineers working in the field, and research programs testing the properties of bamboo. Shows how bamboo has been used in different designs in developing countries and describes the varying properties and uses of different types of bamboo. How bamboo can be harvested, seasoned and jointed to form walls, doors and windows, roofs, floors, ceilings, roof trusses and bridges, and how to weave bamboo. Experiences of Dutch engineers in colonial Indonesia long ago building houses, roads and bridges, combined with similar original English material, plus the results of modem research, with the addition of the latest knowledge and a case study from Costa Rica. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/

"Complete Book of Underground Houses : How to Build a Low-Cost Home" by Robert L. Roy, 1994, Sterling, ISBN 0806907282



Choose an earth-sheltered or underground home and let an expert show you how to excavate and build it. Roy is director of the Earthwood Building School. Detailed instructions on choosing a site, excavating and building, waterproofing, insulation, drainage and more, with case studies, photos and diagrams, and further resources. Written with care to help non-professionals avoid the pitfalls. From Dirt Cheap Builder:
http://store.yahoo.com/dirtcheapbuilderbooks/combookofunh1.html

Green Home Building: Sustainable Architecture: Earth Sheltering -- Earth-Sheltered Houses -- resources, books, plans, links
http://www.greenhomebuilding.com/keepcool.htm

Sustainable Building Sourcebook -- from the City of Austin's Green Building Program. Covers water -- indoor water conservation, composting toilets, greywater irrigation, harvested rainwater, etc.; energy -- passive solar design, photovoltaic systems, gas water heating systems, energy efficient appliances, lighting, and more; building materials, solid waste, green building professionals directory, and more.
http://www.greenbuilder.com/sourcebook/

Greenbuilding email discussion group:
To Subscribe: greenbuilding-subscribe@crest.org
Online archive for Greenbuilding discussion group (searchable):
http://www.crest.org/discussiongroups/index.html

"The Natural Builder" book series, updated version (3rd printing) -- easy-to-read books are full of detailed, concise information and tips needed to build naturally. A must-read for anyone interested in earthen construction and plastering. Vol. 1: Creating Architecture from Earth; Vol. 2: Monolithic Adobe Known as English Cob; Vol. 3: Earth and Mineral Plasters. Each book in the series is a concise yet detailed summary of information produced from the work and knowledge of many experts in the field.
http://www.naturalbuilder.com/

"Shelter" by Lloyd Kahn, Bob Easton (editors), reprint 1996, Shelter Pubns, ISBN 067976948X More than a thousand photographs and drawings of houses around the world in this just-reprinted classic, plus text descriptions and even plans. An eye-opener and an inspiration. Kahn has been a carpenter and a photographer, and an editor of Whole Earth Catalog and Domebook 2 in the 1960s. Shelter is the record of his wanderings in the 1970s to document building traditions throughout the world, and the counter-culture in the US. Caves, huts, barns, yurts, domes, stud-frame, mortise and tenon, tree houses and more, made of stone, wood, adobe, rammed earth, sod, plaster, canvas, reed, bamboo. From Shelter Publications: http://www.shelterpub.com/_shelter/shelter_book.html

"Architecture Without Architects" by Bernard Rudofsky, 1964, Doubleday, ISBN 0-385-07487-5; 1996, John Wiley & Sons, ISBN 0902620789; "Architecture Without Architects -- A Short Introduction to Non-Pedigreed Architecture", Reprint edition 1987, University of New Mexico Press, ISBN 0826310044

Underground loess village in China

Originally an exhibitation at the Museum of Modern Art in New York, this is a collection of extraordinary photographs of habitations, from the Dogon villages south of Timbuctou to underground villages carved out of the loess soil in China. It's what Rudofsky calls "communal architecture", produced by the spontaneous and continuing activity of a whole people with a common heritage, acting within a community of experience. What they have in common is that they fit. Rudofsky offers them as lessons on how to live and let live.

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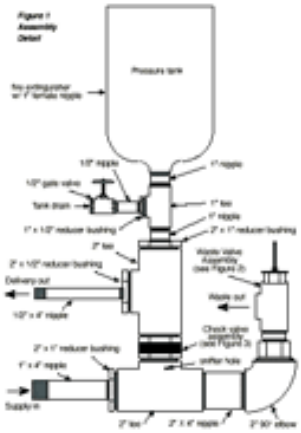
Water-powered water pumps

Hydraulic ram water pumps use downhill water pressure to pump water much higher than it started, with no other power needed. A 20ft fall is enough to push water 150 feet above the source or more. Or as little as a 2ft fall between the water source and the pump at a flow rate of 1 to 3 gallons per minute is enough to pump water 20ft higher than the source -- as much as 4,000 gallons a day, depending on the model.

No modern magic this -- ram pumps were invented more than 300 years ago. A more recent variation is the High Lifter pump, which uses different principles to do the same thing. Ram pumps are noisy, high lifters are silent and can work with less water, but the water has to be clean and grit free, while the ram pump is not so fussy.

Folk hydraulic ram pump

These pumps can be expensive. **Home Power** magazine has several good articles on the pumps online (Acrobat files), including designs and instructions for a cheap ram pump you can build yourself using off-the-shelf materials and a recycled fire-extinguisher.


Build your own ram pump

http://www.homepower.com/download2.htm
Download direct:
http://www.humboldt1.com/~michael.welch/extras/rampumps.pdf

High Lifter pump maker Alternative Energy Engineering is now part of solar electric company Applied Power Corporation.
http://www.solarelectric.com/
More information on the High Lifter Pump
http://www.solarelectric.com/products/level3_179.htm

More information about **High Lifter** pumps from supplier Mark Snyder Electric -- Application & Installation, How High Lifters Work, Question & Answer, Not a Ram Pump (the differences). Also sells ram pumps.
http://www.marksnyderelectric.com/catalog/waterpoweredpumps.html

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Fleming Hydro-Ram pumps are powerful, lightweight, practically maintenance-free, and cheaper. From The Ram Company: http://www.theramcompany.com/

The **Bamford "Hi-Ram Pump"** is a simple, low-cost, self-powered water pump using new patented technology. The principle is similar to conventional ram pumps, but its construction and characteristics are different. The heart of the pump is a stainless steel adjustment tube, and a free-floating high-impact plastic ball. It is quickly adjusted using alternative tubes, and the plastic ball gives quiet operation. While much higher outlet pressures are possible, the 25 mm (1 inch) pump can lift about 1500 litres of water daily to a height of 20 metres, using 2 to 3 metres drive head and 20 litres a minute inlet flow. The pump will operate when totally underwater. It can be made to supply compressed air or to provide a direct mechanical output to drive other devices, and can also act as a suction pump. Made with an eye to the needs of developing countries. Priced from about US$125.
http://www.bamford.com.au/rampump/

Hydraulic Rams -- Computer Simulation and Optimum Design
Although the hydraulic ram pump has been around for roughly 200 years, its design has been largely left to trial and error. Here is a computer-aided method for improving performance. Y.C. Chiang, Ali A. Seirig, Mechanical Engineering Department, University of Wisconsin, Madison, Wis.
-- From *Computers in Mechanical Engineering*, January 1985 (with thanks to Kirk McLoren)

HYDRAULIC RAMS
COMPUTER SIMULATION AND OPTIMUM DESIGN

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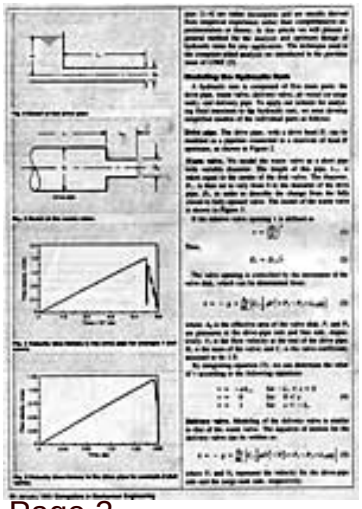

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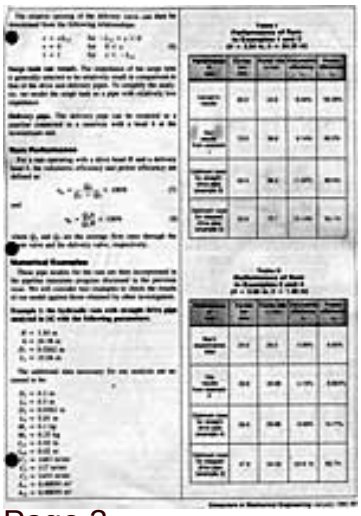

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Good overview of ram pumps and their uses and restrictions from the **Working Group On Development Techniques** (WOT) in Holland (also rope pumps, windmills):
http://www.wot.utwente.nl/wp/us/ram.html

Dutch engineer **Gert Breur's** ram pumps are simpler, and they not only pump, they can also suck water up from a low-lying area into a stream. Breur has also developed a small ram pump, easy to assemble, using standard "garden" materials except for some pressure tube. Materials list, numbered pictures and "exploded-view" photos show you how.
http://www.wot.utwente.nl/wp/us/breurram/index.html

More about Gert Breur's water-powered suction ram pumps, including Spanish text; also rope-pump and more:
http://www.geocities.com/ResearchTriangle/System/7014/index.html

Updated ram design from **Gravi-Chek** -- The Gravi-Chek pump is the newest technology available in the ram pump industry. The Gravi-Chek pumps have been tested by the Center for Irrigation Technology at the California Agricultural Technology Institute. There are three models available, providing water at rates from 20 to 16,000 gallons per day, depending on the installation
http://www.gravi-chek.com/

Hydraulic ram pumps -- 6-page Technical Brief, Intermediate Technology Development Group (ITDG), Acrobat file, 190 K
http://www.itdg.org/html/technical_enquiries/docs/hydraulic_ram_pumps.pdf

Overview of ram pumps (and hand pumps) with some useful diagrams, from the (ahem) "**Sourcebook of Alternative Technologies for Freshwater Augmentation in Small Island Developing States**/Part B - Technology Profile/2. Technologies Applicable To Very Small, Low Coral Islands/ 2.1 Freshwater Augmentation Technologies/2.1.3 Pumps":

http://www.unep.or.jp/ietc/Publications/TechPublications/TechPub-8d/pumps.asp

Ram Pump System Design Notes from the Development Technology Unit, School of Engineering, University of Warwick, UK: Online papers -- Introduction to hydraulic ram pumps, how ram pumps work, instructions for use and manufacture, designs, plans and drawings; also low-cost handpumps.
http://www.eng.warwick.ac.uk/DTU/lift/index.html

Another ram pump overview, more diagrams, equations, tables:
http://www2.ncsu.edu/eos/service/bae/www/programs/extension/publicat/wqwm/ebae161_92.html

Lifewater Canada -- Hydraulic ram pumps and Sling Pumps. Lots of great information at this site.
http://www.lifewater.ca/ram_pump.htm
See also Handpumps Resources -- Handpumps and water well drilling training for safe drinking water:
http://www.lifewater.ca/

Designing a Hydraulic Ram Pump -- US AID Water for the World Technical Notes
http://www.lifewater.org/wfw/rws4/rws4d5.htm

"All About Hydraulic Ram Pumps--How and Where They Work", Don R. Wilson, 1994 (updated), Atlas Pubns, ISBN 0963152629 -- This book explains in simple terms and with illustrations how the ram pump works, where it can be set up, and how to keep it going. The second section of the book gives step-by-step plans for building a fully operational Atlas ram pump from readily available plumbing fittings that requires NO welding, drilling, tapping or special tools. The final chapter shows how to build an inexpensive ferro-cement water storage unit with up to 15,000 gallon capacity. From Grove Enterprises, Inc.
http://www.grove.net/~atlas/

Rife Hydraulic Engine Mfg. Co. Inc. has specialized in pumping water without electricity or fuel for over 117 years -- one of the original Water Ram manufacturers and the oldest. Manufacture 19 different models of ram pumps, pumping up to 500 ft vertically and producing up to 350,000 gal/day. Rife also manufactures the Slingpump, which works on the flow of a stream, creek or river and can lift water up to 82 ft vertically and up to one mile away, 24 hours a day with no maintenance.
http://www.riferam.com/

Needed by African farmers: simple water pumps -- Finding

sufficient water for irrigation is one of the major challenges facing farmers in sub-Saharan Africa, where only 4% of arable land is irrigated, severely constraining agricultural productivity in a region where an estimated one third of the population is chronically undernourished. Locally produced low-cost treadle pumps instead could make an important difference and could boost food security in the region significantly, says a new report, "Treadle pumps for irrigation in Africa". Treadle pumps make it easier for farmers to retrieve water for their fields or vegetable gardens, and they are cheap and easy to handle. If pumps are produced locally, they can also create jobs and income.Many African farmers are still irrigating very small plots of land using bucket-lifting technologies, which are slow, cumbersome and labour intensive. Treadle pumps are far more efficient and user-friendly. They can be used in a comfortable way, the farmer stands on the treadles, pressing the pistons up and down, lifting up to five cubic metres per hour (5,000 litres).
http://www.fao.org/news/2001/010103-e.htm

Intermediate Technology books

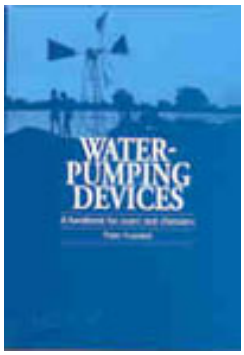
"Manual on the Automatic Hydraulic Ram for Pumping Water" by Simon B. Watt, 1978, Intermediate Technology, ISBN 0903031159
Assumes no specialised knowledge of hydraulics, needs access only to basic machine tools and a few common engineering materials. Describes how to make a hydraulic ram from mild steel, some nuts and bolts and two rubber disks. Part One contains details of how to make and maintain a small hydraulic ram on a suitable site, Part Two takes a more technical look at ram performances and design considerations and also contains a useful bibliography. Excellent, clear plans for making your own hydraulic ram water pump from standard pipe fittings.
http://www.developmentbookshop.com/book.phtml?isbn=0903031159

Prototype ram pump in India -- built for one-tenth the commercial price

"Hydraulic Ram Pumps: A guide to ram pump water supply systems" by T.D. Jeffrey, T.H. Thomas, A.V. Smith, P.B. Glover and P.D. Fountain, Intermediate Technology, ISBN 1853391727
Step-by-step instructions on designing, installing and operating hydraulic ram pumps. Illustrations and diagrams, details of a pump designed for a local manufacture, notes for those developing their own model.
http://www.developmentbookshop.com/book.phtml?isbn=1853391727

"How to Make a Rope Washer Pump" by Robert Lambert, 1989, Intermediate Technology, ISBN 1853390224
How to make a simple, cheap pump which can raise water 18 feet from a stream or well at an output of 1 litre per second. Designed to irrigate small plots. A rope is pulled up through a pipe by means of a pulley wheel -- an old tyre. Fixed to the rope are flexible rubber washers (cut from another tyre) slightly narrower than the pipe; as the washers are pulled up through the pipe water is drawn up and discharged at the top. Rope and washers pass around the pulley wheel and return to the bottom of the pipe. Clever!
http://www.developmentbookshop.com/book.phtml?isbn=1853390224
How to Make a Rope and Washer Pump -- VHS-PAL format video
http://www.developmentbookshop.com/book.phtml?isbn=1853393568

"How to Make and Use the Treadle Irrigation Pump" by Carl Bielenberg and Hugh Allen, ITDG Publishing, ISBN 1853393126
The treadle irrigation pump is able to lift up to 7,000 litres of water per hour using the power of the human body, and can be made locally at low cost in small-scale metalworking shops. Its acceptance in Bangladesh where it was first developed in 1984 is extraordinary, with over 500,000 pumps estimated now to be in use. The current design in this manual has evolved from the Bangladesh original into a fully portable pump with both lift and pressure capacity and is especially good for use in permeable soils where water cannot easily be distributed through channels.
http://www.developmentbookshop.com/book.phtml?isbn=1853393126



"Water Pumping Devices: A handbook for users and choosers", by Peter Fraenkel, 2nd edition, ITDG Publishing, ISBN 1853393460
Efficient and effective irrigation of the land can have a dramatic effect on the agricultural output and economic well-being of a community. At the heart of effective irrigation lies the problem of lifting or pumping water, and this handbook, newly revised and reformatted, surveys the water-lifting technologies that are available and appropriate for smallholdings. It is a detailed and practical review of the options, especially for irrigation but also for other purposes, and the costs and general suitability of the different technologies are examined with the aim of enabling farmers and policy makers to make informed choices.

http://www.developmentbookshop.com/book.phtml?isbn=1853393460

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Home

Chinese watering cans

Southern Chinese peasants have a lot of ways of watering their crops, but the most common way is a pair of watering cans on a carry-pole across the shoulders. These are high-powered cans with long spouts that throw the water out either side in a drenching spray. They cover a lot of ground very quickly.

Three-man treadle irrigation, propelling a wooden-chain irrigation pump near Canton a hundred years ago. (F.H. King, "Farmers of Forty Centuries")

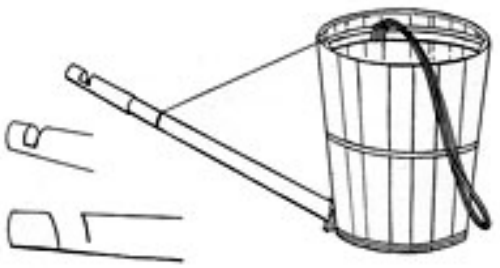
Usually there's a small reservoir at the corner of the field, and the farmer simply climbs into it, cans and all, to get a refill, but a big tub will do, or a 55-gallon oildrum cut down the middle and laid on its side.

"The equipment used for applying water and liquid fertilizer is of interest. Two wooden buckets are employed each about 1 1/2 feet high and 1 1/2 feet across with a capacity of forty catties each.

Traditional farming: watering watercress in Hong Kong

"Each bucket is equipped with a spout 2 1/2 feet in length, 2 1/2 inches across at the base and tapering to two inches in diameter at the end, supported by a wire to the top of the bucket.

"At the end of the spout instead of a rose there is a simple device which enables the water as it leaves the spout to spread out in the form of a flat spray. The end of the spout is closed; about one inch from the end is a V-shaped cut from the top sloping obliquely backwards and continuing nearly across the spout. A small piece of metal is soldered on to the distal end of the V-shaped cut thus



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sealing off the tip of the spout. This piece of metal is convex. When the liquid passes down the spout it impinges on the small convex surface and is thus forced out vertically and laterally as a flat spray.

Abandoned wooden watering can, rotten and broken, Lantau, Hong Kong

"Across the top of each bucket is a wooden handle and one man carries a pair of buckets slung on a pole across his shoulders from which the buckets are suspended by rope. He walks swiftly along the stepping stones and with his hands depresses the two buckets simultaneously, swinging them forwards and backwards, and directs the two sprays of water where required."
-- Geoffrey Herklots, "Vegetables in South-east Asia" (1972)
[1 catty = 0.67 kilograms]

The traditional wooden watering cans worked well, but they're heavy. As soon as the consumer age arrived local metalsmiths started making watering cans out of scrap metal cans, the ubiquitous 18-litre square-section cans that cooking oil and kerosene come in, or the larger round 25-litre oil cans.

A Hakka farmer uses oildrum cans, New Territories, Hong Kong

But by the 1970s this great bit of recycling was replaced by purpose-built zinc cans, usually square-section, and heavier. At first they followed the original recyclers' pattern, with the long spouts let into a corner, which was more difficult to make but it gave the best "throw".

Later this was abandoned, with the spouts entering the side, much easier to make. Later still, the whole thing was abandoned -- when we started the Journey to Forever garden at the Beach House, it was no longer possible to buy a real watering can. All we could get were much smaller cans, for gardeners.

We found a couple of old cans, with spouts in the sides, rusted

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Handmade Projects
Ichijima
Japan

High-power rose -- tricky to make

and leaking, the handles worn away -- but they had the big roses which work so well and are now impossible to find.

New can and an old one, repaired but still inferior

We repaired one of the cans but it's not very good. So we made a real one, out of an empty 18-litre oil can from the dump -- or rather two of them, one for the can, and one cut up to make the spout. It works much better -- it's lighter, and the water sprays further.

See **Watering can** plans for details. We haven't figured out how to make new roses yet, but we're working on it. We're trying twin male/female moulds using our friend Graeme Morris's recipe for a rock-hard putty made of glass-fibre resin and lime -- that way we should be able to get the holes right.

Canny farmer

-- From Keith's diary, the Beach House, Lantau Island, April 1999

Farmer Chan's old wife, Mrs Farmer Chan, who lives on the corner, came here this morning while I was sitting on the seawall having my morning cuppa in the sun, and tried to half-hitch one of my watering cans.

First she wandered round commenting on the garden and the crops and so on, said lots of nice things and gave me some good advice (which she does every now and then even when she's not after my watering can), then she siezed the can and said: "I need this."

Yes, I said, so do we, but you can borrow it, as long as you bring it back this afternoon. No, she didn't want to bring it back. And so on.

Small watering can from China -- no use for farmers

Her watering cans had gone rotten at the bottom of the spout and leaked, and no, you can't buy them anymore, not in Yuen Long where all the local farmers used to get their stuff, nor even in Sheung Shui, and not even in China -- only the small ones like those two over there, no use lah. Too small, and the spout's not long enough, it doesn't throw the water.

She wanted the old one I'd repaired -- we didn't need it, she said, we had a new one, the one I'd made out of a cooking oil can (she knew I wouldn't give her that one!). But she accepted that we needed both cans for balance or you fall over.

She much admired the new one -- strong and light, with the spout in the corner not the side, good, and it doesn't even need a wire to hold the spout up. Only the spout's two inches too long so she told me where to cut it off (she's right).

I offered her the other old one, that I haven't repaired (I made the new one instead), and suggested she repair it, it's easier to fix than hers, I even told her how, but she didn't want it.

An Indonesian farmer uses oildrum watering cans at a city farm in Jakarta.

Then she went home, quite happy, no problem -- it was worth a try, I guess, who can tell what a foreign devil might do.

Her husband's the local healer, though he does much less of it now than 17 years ago when I first met him -- there used to be lots of damaged people there every evening when he came back from the farm.

I'd twisted a knee out of joint riding a motorbike over some rocks and he put it back for me, excellent job he did -- my introduction to Chinese medicine, very impressive. Our old neighbour Chat Suk hurt his foot the other day, he was limping badly, and Farmer Chan fixed

it for him -- the pain and swelling were gone the next day. I suppose he's been fixing Chat Suk for about 40 years.

I guess they're pretty rich people now, like everyone else here it seems, because of the land (their sons drive HK$300,000 Toyotas), but he still takes his crops and herbs to the Cheung Chau market on the 6am ferry every morning, seven days a week.

He takes two basketsful on a carrying pole -- but one of the sons drives him to the ferry pier at Chimawan these days. He used to walk past our house to the pier every day when I lived in the next valley 17 years ago, and then back again in time for lunch.

"I'm getting sick of this," he told me one hot day. "I think I'll buy a car."

His wife never acknowledged my existence, even after I came to live here at the Beach House. At first. She often rakes the beach for clams, so one day I gave her a really massive clam I found, and I sort of popped into existence, just like that. Now we're friends. But that doesn't mean she can steal my watering can.

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Watering can plans

Materials:
Two 18-litre square-section cooking oil tins, one for the can, one for the spout
2 x 5 x 32cm wood for the handle
Four 1" woodscrews to secure the handle

Fig. 1 Top view -- leave the "front" part of the lid in place to prevent the water splashing out.

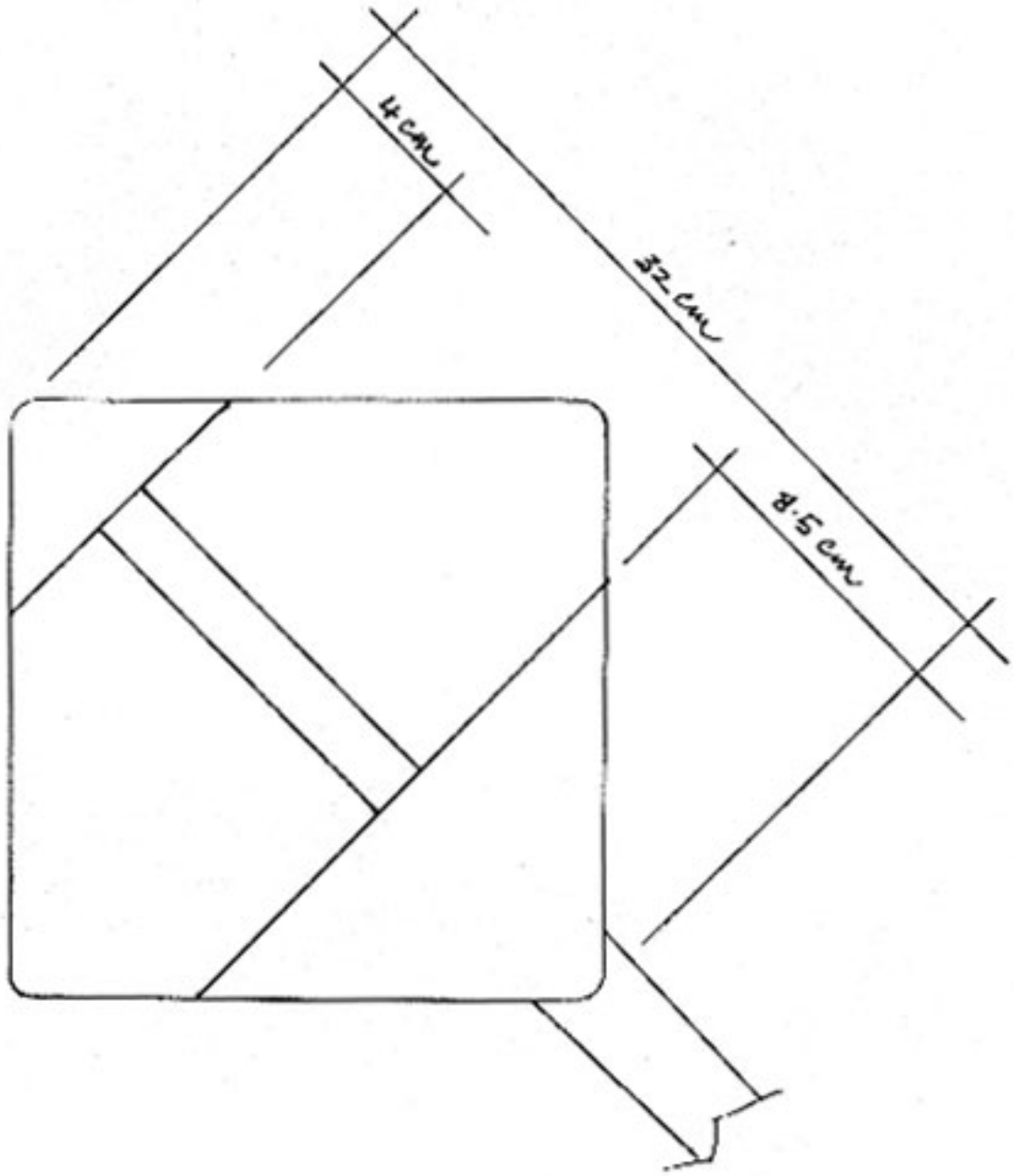


Fig. 2 Fitting the spout -- templates

Top: cut the metal for the wider end of the spout to this shape. Make it 1cm longer than needed, then make 1cm-deep snips into the end every 1cm. When the spout's assembled and fitted into the hole in the can, splay the snips out to make a joint, then solder inside and out. The metal should be 19cm wide at the end to allow 1.5cm for joining flaps -- see bottom right: fold, bend over, flatten, solder.

Bottom left: Stick this template over the bottom corner of the can and cut a hole this shape for the spout.

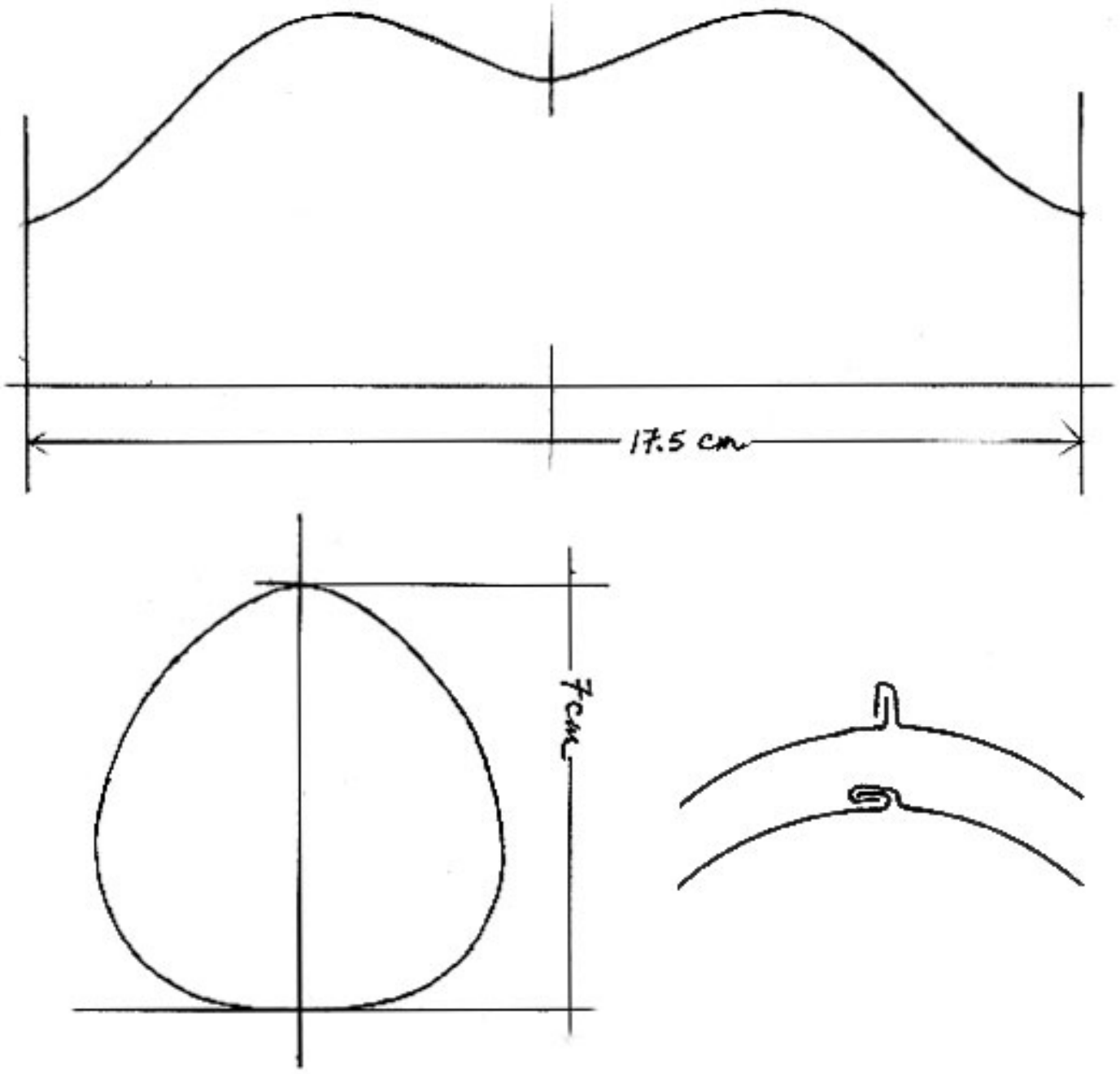
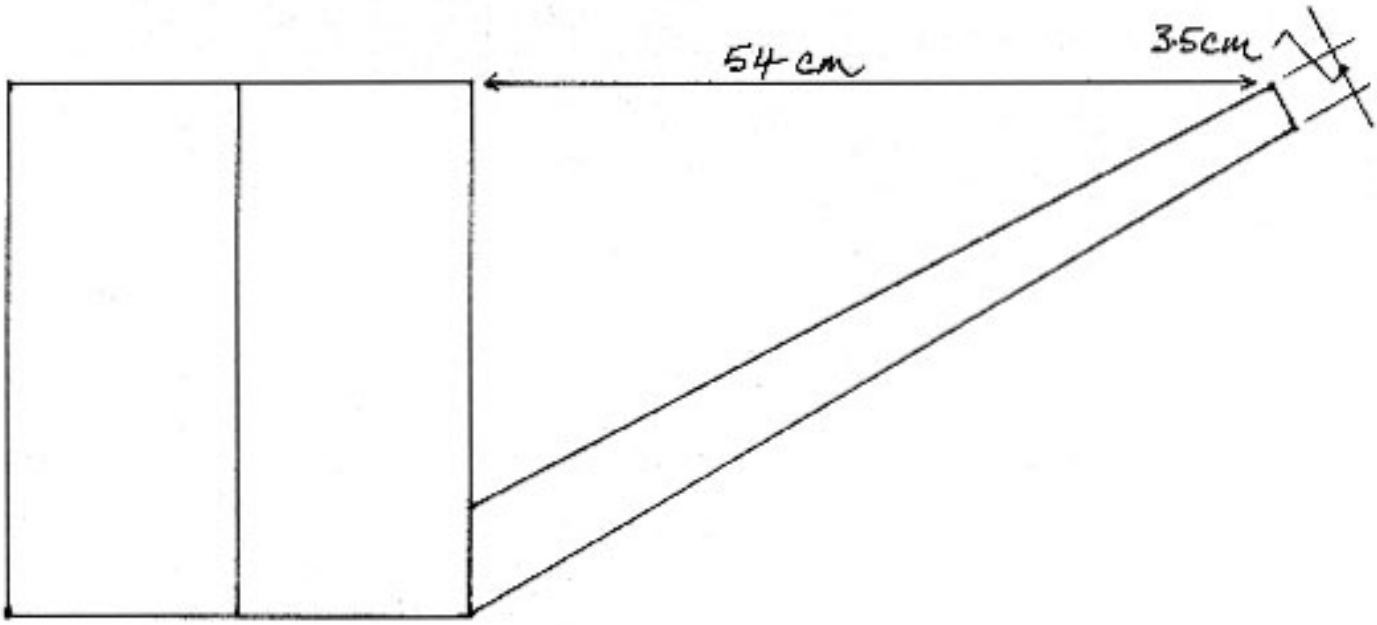


Fig. 3 The end of the spout should be level with the top of the can, and 54cm away from it.



Solidly soldered, the spout doesn't need wires to support it.

This is the plan for the green watering can on the right

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Hoes

An old couple worked this Lantau hill farm (the old woman is working in the field in the centre). The beds descended right down the mountainside to the sea -- all done by hoeing.

Tsui Kam-pui of Tai Long Wan village hoeing in his taro field. He owned a rotovator, but it seldom left the shed.

Hoe for victory!

Gardeners dig (except no-dig gardeners), but most small farmers in the Third World use hoes, especially in the East. A Chinese peasant wouldn't have any use for a spade or a fork -- they remake the neat rows of beds in their fields several times a year, with a hoe. They work away at a relaxed, steady pace, and can do a whole field in a day. Once you've mastered a hoe, you won't want to use anything else.

Swiss hoes

This hoe is used by villagers in the high valleys of the Swiss Alps. Light, strong, sharp and well-balanced, such a hoe encourages a steady, tireless rhythm of work. We've had this one for 14 years, and it's as good as new.

This hoe has a beautiful, shaped stock, like an elongated axe handle, great to use. It also came from the Swiss mountains, fitted with a huge blade like a big shovel, weighing 5lb, used for digging potato beds. We removed the blade and replaced it with a standard 2lb blade from China, which was fitted for a round stock, not a flat one like this, so it's secured with two shims.

This pointed, heart-shaped hoe really bites into hard ground. We cut it to shape from a standard 2-1/2 lb hoe from China. The stock was somewhat warped (half-price!), which gives the hoe a better angle of attack. Stocks sold in Hong Kong are round, and heavy, so we narrowed it with a spokeshave to give a better grip and lighter weight.

Other hoes

A 2lb hoe with the blade cut to 4 to 5 inches and serrated on the inside with a hacksaw makes a fine weeder, both chopping and tearing the weeds and mixing the shreds up with the surface soil to make a mulch. Angle the serrations one way on one half of the edge and the other way on the other, meeting in the middle in a V.

A 2lb hoe with the blade cut to a V-shape with a blunt, rounded point and the stock shortened to about 2ft is great for square foot gardeners -- ideal for loosening the topsoil of a single square foot and mixing in some compost after taking out a crop.

Hoe blades are bevelled on the OUTSIDE. Keep them sharp.

Fitting handles and stocks

In humid weather wood absorbs moisture and swells, when the weather's dry the wood dries out and shrinks. So the stock that was tight and solid in the wet season suddenly loosens when it's dry. Stand it in water overnight, and it will tighten again. Better, stand it in linseed oil. Best of all, use biodiesel.

If you fit the stock to the tool in the first place using Alexander Weygers's method, it

will never come loose, rain or shine.

"Heat the handle socket to the point of scorching the wood, then quickly clamp the shovel in the vise and hammer the handle home. If you do not succeed on the first try because the handle does not match the socket curve well enough, you may have to preheat the end before hammering it into place. You can easily accomplish this heating by dipping the curved end in water and holding it in the flame until the water has evaporated and the wood begins to scorch. Repeat this operation maybe four or five times. Between the steam of the evaporating water and the heat of the fire, the entire curved end becomes heated to the core, momentarily making the wood limp. At the same time the handle socket should be heated to the point of scorching wood. Then quickly clamp the blade in the vise and hammer the limp handle into the socket. It will easily follow the curvature of the socket under the hammerblows on the other end of the handle. Following the curvature of the socket, the limp end flexes as if it were made of rubber." -- Alexander G. Weygers, "The Complete Modern Blacksmith", Ten Speed Press, 1997, ISBN 0898158966

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Billhooks and sickles

Traditional peasants on Lantau Island always carried a billhook tucked into their belts, like this restored one (left, and detail, below), using them for a wide variety of small jobs. But none of the stores stock them now, the small workshops that made them have gone out of business.

What they do stock is a very inferior cutter that's the wrong shape for the job (no hook), has the wrong kind of grip, and is made of brittle, mass-produced steel that won't take an edge. Useless.

After a lot of searching, we found a good billhook at a small store in Kowloon: good, hammered steel that takes a keen edge. It was also fitted with a socket for a handle, like the old one above, but the pitch was wrong, upsetting the balance, so we cut it down to a tang, flattened it, and set it into a strong wooden handle secured with a through-bolt (right).

A Filipino friend offered to get us a billhook from the Philippines, so we gave him a template for a tool something like the new billhook.

The blacksmith in his village didn't follow the template, but he let it influence him: the result is a something halfway between a billhook and a bolo, the traditional Filipino cane-cutting knife.

We fitted it with a two-handed grip a bit like the hilt of a Japanese sword: shaped hardwood split in two, with recesses cut in each half for the tang, secured with a through-bolt and a ferrule at each end.

This is by far our best cutter, light, perfectly balanced, and the progressive, downward sweep of the blade does the work for you, you don't have to hack away. It's much better than a machete.

The blade-length is 33 cm, back thickness tapering from 5mm to 1mm.

A Load of Old Billhooks -- A Private Collection of Early Edge Tools: Bob Burgess, of Heytesbury, England, has been collecting old billhooks for years.
http://www.billhooks.co.uk/

Leonelli Attrezzi Agricoli da Taglio -- Italian traditional edge tool maker, dozens of different types of billhooks, sickles and more.
http://www.leonelliattrezzi.com/index.html
Catalog here:
http://www.leonelliattrezzi.com/catalogo.html

Reaping the harvest

This is a traditonal Chinese rice-harvesting "sickle", still in use up to 15 years ago. Note the tiny serrated blade near the top on the right, only 3" long. The "arm" is used to gather in the rice stalks, then the cutter is turned and the blade brought to bear. This is a truly primitive tool. Slow work!

It took a long, long time for European reapers to figure out that a sickle has to

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curve backwards from the handle before sweeping forward to the point (see below).

Evolution of the sickle (Tresemer)

"Early cutting tools were animal jawbones with sharp chips of flint stuck in where the teeth had been, or crooks of wood, also with flint chips. These designs all used the idea of a hook—the tool was passed in behind the standing grasses and jerked towards the body. Early bronze sickles were also hefted at a right angle to a handle of wood or bone. The blade was eventually made to curve back to the right, and then was continued in a long curve to the point at the left.

Thus the weight of the tool was evenly balanced and the wrist was less strained after wielding the sickle accurately hour upon hour." -- David Tresemer, "The Scythe Book", 1981, Reprint 1996, Alan C. Hood, ISBN 0-911469-14-1

Scythe -- a highly evolved tool developed over millennia

One man with a good sickle could cut up to an acre in a day. A man with a scythe could cut three to four acres a day. The standard scythe blade used today is 27.5 inches long, made of hammered steel in 26 separate steps, and curved in every dimension to optimize the cut. Older blades could be up to 4ft in length, usually used for mowing lawns.

Scythe with wooden grain cradle

Scythes fitted with cradles or bows not only cut the grain, they scoop it up and lay it to the side out of the way in a neat swathe, ready for binding into sheaves, saving time and preventing wastage.

Lantau islanders use a sort of sickle to cut rough weeds -- the rusty one below. We improved one of these (bottom) and serrated the edge at the end of the blade, which works much better, but it's still a far cry from a swept-back sickle.

Rust

Badly rusted wood chisels ...

Iron and steel don't exist in nature in pure form and are not stable, quickly decomposing with air and moisture into iron oxide -- rust.

Steel tools that cut plants and bite into soil contact plenty of moisture and must be kept clean to prevent rust.

We've found biodiesel to be an excellent cleaner and lubricator -- unlike mineral oils, it's not toxic, ideal for organic growing. It protects against rust to an extent, but linseed oil gives better protection. Apply regularly.

Here's a good way to remove all rust from steel tools. We've used it a lot in restoring old tools deeply pitted with rust.

You need an ordinary car battery charger, lye (Red Devil or any caustic soda -- sodium hydroxide) and a plastic bath -- a standard 25-litre plastic container with one side cut off makes a good bath.

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This old hoe is made of fine English steel, worth saving

... cleaned with lye and electricity

Work outside -- the process emits some fumes. WARNING: Lye is highly corrosive, even though this is a weak mixture -- wear rubber gloves, keep clean water handy.

Mix two tablespoons of lye with 10 litres of water in the bath. Attach the positive (red) terminal of the battery charger to a spare stainless steel kitchen knife or spoon and put it in the bath. Attach the negative (black) terminal to the rusted tool -- scrape some of the rust off first to make sure it makes good contact. Put the tool in the bath on a stone, not touching the knife.

Switch on the charger -- the rusty tool (and maybe the knife) should begin to send off streams of tiny bubbles. Leave it on for 24 hours. If it's a large tool, take it out after 12 hours and attach the terminal to the opposite end to spread the effect.

After 24 hours a lot of the rust will have flaked off, and the rest will have been converted to oily black stuff that can easily be scrubbed off in hot, soapy water. The tool emerges clean, all rust removed or converted, even into the deepest pinholes of corrosion.

The hoe derusted, ready for re-edging

NOTE:
We've tried to find out the composition of the oily black deposit left on the tools, but without success. If anyone knows, please tell us -- thanks.

Old Chinese logsplitter, folded and heat-welded by a blacksmith, crude but effective -- thoroughly cleaned by the electric treatment

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A Better Rat Trap

Rats are a menace and a worldwide scourge. City people think of them as disgusting creatures that infest sewers and spread disease, and that's true enough, but the real problem is what they eat, especially in farming areas.

It's estimated that total crop losses caused by rodents, mostly rats, each year would be enough to feed 200 million people, nearly as many as the population of Indonesia. That's probably a low estimate, and post-harvest damage is about the same again.

In Southeast Asia rice crop losses due to rats are at least 15%: it's not unusual for farmers to report 15-30% losses, and losses can be as high as 50% or even 100% in a bad year.

Bandicoot rat

In Indonesia, rats are the number one pre-harvest pest of rice, with about 17% of the harvest lost each year -- enough rice for 20 million Indonesians. In Laos, rodents are the second most important agricultural pest in mountainous regions, and the one over which farmers feel they have the least control. Rodents are one of Vietnam's top three agricultural problems.

Southeast Asian farmers now consider rodents (not insects, weeds or lack of soil fertility) to be the main factor limiting rice production.

Africa also suffers. In Tanzania, rats can eat more than 80% of the planted maize seeds in an area. During bad years rats have wiped out hundreds of square kilometres of maize, the country's staple crop, destroying 50% of the crop or more. All the African countries suffer. It is the same everywhere, on all continents. Losses of stored rice and maize are reported to be even more severe in Latin America.

In Pakistan, rats consume several million tons of stored wheat grain annually; in Bangladesh losses of grain stored inside houses are estimated

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Black rat

at US$620 million a year, in houses only. In India, rats outnumber humans ten-fold. The United States has an estimated 1.25 billion rats and they cause at least $19 billion in damage a year. Worldwide, 3.5 million rats are born every day.

The main culprits are the roof rat (Rattus rattus, also known as the black rat, ship rat, fruit rat, rice field rat, and by us as bamboo rats), the Norway rat (Rattus norvegicus, or sewer, barn, or brown rat -- pictured top of page, artwork by Karen Phillipps), more a pest in temperate regions than in the tropics, the bandicoot rat, a big Asian rat, and the house mouse (Mus musculus). One adult Norway rat eats 5 to 9 kg of grain a year, roof rats eat 3-4 kg a year, bandicoots 6-9 kg a year, and house mice 1 kg a year. With billions of rats in some countries, the losses are immense.

Rats also pose severe health risks. It was the black rat of East Asia that brought the Black Death (Bubonic Plague) to Europe, killing a third of the population. Plague is still a problem throughout the world today, with annual outbreaks in parts of Africa that kill hundreds of people.

Rats are closely associated with other diseases such as Leptospirosis and can rapidly spread other gastroenteric diseases such as Cholera and Salmonella. Recent research in Mozambique found that 18% of villagers tested positive for leptospira.

Buff-breasted rat (bamboo rat)

Contamination of water and food inside houses by rats is a serious health risk to rural people. In parts of Africa up to 10% of people are regularly bitten by rats while they're asleep, leading to secondary infections and rat bite fevers from bacteria entering the wounds. And rats contaminate stored grains with their urine and faeces, increasing the chance of disease.

Rats are clever, they're tough and very capable. And they breed all year around. Young rats reach sexual maturity at three months. A female rat will have as many as five litters a year, with up to 10 pups per litter, or more. This can mean frightening population growth. Local populations tend to swell along with the available food supply, and as the crops mature, swarms of rats appear to overwhelm the harvest.

Farmers often feel desperate, or just plain helpless in the face of such an onslaught.

The usual "control" method is to use poison, but it doesn't work very well. Smallholder farmers who can afford it use fast-acting, acute poisons like zinc phosphide. It's sold as a concentrate to be mixed with cereal bait and many farmers can't do it accurately or safely. The poisons are a threat to

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other species and to humans, and the rats quickly develop resistance to them.

Also, these rats are not dirty city sewer rats, they're wild animals living mainly on grains and fruit and they're a major source of protein food in many 3rd World areas -- not much different to rabbits. Using poisons to control them can lead to less food, not more. There's growing demand in many 3rd World countries for effective rat controls that don't rely on poisons.

The best answer, if not the only answer, seems to be to use a combination of traps and natural predators.

Traps

Trapping, to be effective, requires a better trap than most. There are very many different types of rat traps, but few of them work well. We found one that works very well indeed. We've caught many hundreds of rats with these traps, probably thousands (we lost count). They never failed, they're perfectly safe to use, and they're simple and easy to make at village level.

This is the wire-cage spring-door live trap used in South China. Here's **how it works**, and here's **how to make one**.

How to Make Springs -- online book, written "for the benefit of someone who has (or can gain access to) basic hand and power tools". Arranged in logical order presuming minimal knowledge of the metalworking trades or of springmaking, cross-linked to provide a forward path through the entire manufacturing process.
http://home.earthlink.net/~bazillion/intro.html

Here's a different kind of trap, from Zimbabwe -- a **bucket trap**. We haven't used this one, but there are good reports of its use from Africa and India. Again, totally simple and anyone can make one.

Predators

Cats are not effective, though they might seem to be. Cats don't kill many rats, if any, but they do frighten them away -- households with cats usually have no rats. But the problem isn't solved -- the rats simply move in next door where there's no cat.

The cats at the Beach House, our headquarters in Hong Kong, were

completely useless, though the place was overrun with bamboo rats coming down from the hillsides.

Barn Owl Centre of Gloucestershire

Dogs aren't much use either. The beautiful Nibbles, the Beach House dog, loved chasing rats, but she was much too smart ever to risk actually catching one -- cornered rats are vicious. (She chased the cats too, and never caught them either.) (But she was great at catching fish.) Terriers might be useful around the house, but the real answer is owls. A pair of barn owls with five chicks will eat at least 3,000 rodents in one breeding season, and you can have lots of pairs. They're found all over the world, and it's easy to attract them. See **Rats and owls**.

Prevention

Traditional grain silo at Korhogo on the Volta River.

You can't rat-proof the crop, but you can go a long way towards rat-proofing homes, and especially grain stores. Rats eat their way through wood, and even soft metal. They often chew through electrical wiring, creating a fire hazard. They can fit through much smaller gaps than you'd think. They're excellent climbers (other than bandicoots) and good swimmers. A Nordic rat can jump 30 inches straight up (77 cm).

Bandicoots and Nordic rats burrow right under floors, sometimes collapsing them. Black rats infest roofs (that's why they're called roof rats). Villagers with thatched-roof homes find it really helps to renew the thatch every year -- thatch, palm or nipa roofs are a haven for black rats (use the old thatch for mulch in the orchard).

It helps to keep the place clean and tidy, free of rubble or empty containers where rodents might nest, and free of food scraps, pet food, poultry feed, etc. that might attract them. Have a clear strip round buildings kept free of vegetation. Lop off overhanging branches.

Fit hard metal strips to the bottom edges of wooden doors and their frames, wire netting screens to windows, steel rat guards to drainpipes (one metre above the ground).

Grain storage techniques -- Evolution and trends in developing countries, FAO Agricultural Services Bulletin No. 109, Rome, 1994, Chapter 9 - Rodent control: Control of rodent pests (ignore the stuff about poisons):

Horreos traditional corn cribs in Galicia, Spain.

http://www.fao.org/docrep/T1838E/T1838E1l.htm#Control of rodent pests

Traditional grain store in Japan

These rat-proof grain stores have been in use for 2,000 years or more. Detail, above: note the rat barrier at the top of the leg, and on the steps.

Sonic repellants

... don't work. From a homesteader in the US:

"Hubby bought those -- we still have the mice, and ants. So if anyone would like me to mail you one to try I would be more than happy to do so!! Just please don't mail it back!!"

We had a similar experience (we got our money back). This sums up the expert consensus:

"There is NO device, that is sonic, electric or magnetic, or any combination of these, that has ever been scientifically proven to keep any animal or insect at bay. They don't work. They don't work for any kind of animal." http://UnExCo.com/spoofs.html#sonic

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Silent killers

Photograph by Andy Harmer, Copyright 2003

Keeping rodents in check seems to have been quite a problem even for Nature, or she wouldn't have had to design such a high-tech killer as the owl. The technical specifications of owls read like something from the Mad Science Department at the Pentagon -- except that it works with unfailing efficiency, having been under development for about 26 million years.

Rats and mice are nocturnal, but hiding in the dark won't save them from an owl. Owls have very large, deep and specially adapted eyes that can see in the dark -- and they see perfectly well in the daylight too, better than humans do.

Most likely the rat won't even be trying to hide, because it won't know the owl is there. Owls have special feathers and special comb structures on their wings that muffle the sound of the air rushing by. They fly in an eerie silence, like ghosts -- the rat can't hear the owl, but the owl can hear the rat, and knows exactly where it is.

Owls hear in three dimensions. The specialized part of the brain that deals with hearing is much bigger and more complex in owls than in other birds. The flat, heart-shaped disc of feathers that gives owls their distinct faces works like a radar dish, catching sounds and directing them to the ears. The owl alters the shape of the disk with special sets of muscles to focus the incoming sound-waves from a rodent making the slightest movement up to hundreds of feet away in the dark. The owl can gauge whether the sound reaches one ear before it reaches the

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other -- a time difference of only a few millionths of a second -- and turns in that direction until the sound reaches both ears at the same instant: the prey is then straight ahead, the owl moves in for the kill. Barn owls and other night owls have one ear set higher than the other, and the ear openings are set at different angles: higher or lower sounds tell them how far away the rat is. The left, right, up and down signals create an exact image of the prey's location, even in total darkness.

Photograph by Don Baccus

Barn owls aren't only nocturnal. Their excellent eyesight means they can hunt in the daytime too, and often do so with a clutch of hungry chicks to be fed.

Even hiding under several inches of snow won't save a rat from an owl. The owl lands right on top of the rat, outstretched talons first, then breaks its neck with a twist of the beak. Here's an excellent series of photos of a Great Gray Owl doing just that: http://www.owlpages.com/species/strix/nebulosa/hunting/Default.htm

Owls have special wings, broad and rounded, with a large surface area. They fly without effort and can glide slowly for long periods of time, quartering the land up and down in search of their prey, then flying in fast for the kill.

Owls, and barn owls, are found all round the world, and in a wide variety of habitats -- wherever there are rodents. It's mostly barn owls that farmers around the world are now using for rodent control. They're easily encouraged by installing nest-boxes and perches. Barn owls breed any time during the year, depending on the food supply. A pair may breed twice in a year, and barn owls have been known to nest all year round, raising as many as four clutches. They have a tremendous reproductive capacity and can breed rapidly in response to rodent plagues. They lay three to 11 eggs per clutch, fewer when prey is scarce and more when it's plentiful. The adults eat one rodent a night each, but the chicks will have at least two each, and up to five, depending on the size of the chicks and of the catch. A pair of barn owls with five chicks will eat at least 3,000 rodents in one breeding season. They're not territorial birds, and it's common to have many nest-boxes in action, with dozens or scores of owls working in one area -- a whole colony. In one study 48 nest-boxes accounted for at least 17,000 rodents in eight weeks.

It's better to establish colonies of owls on a community basis rather than on one farm

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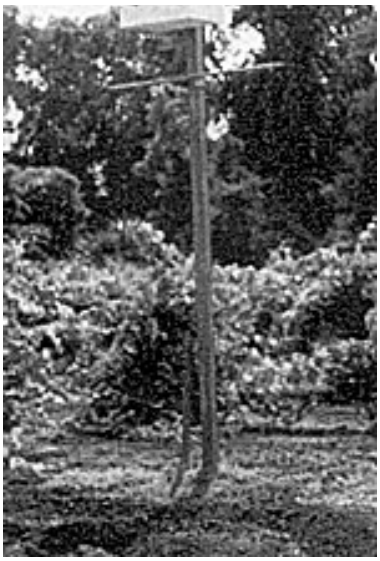

only. The birds hunt over a large area, often flying three or four miles in search of prey. A colony of barn owls will greatly reduce the local rodent population. But they won't wipe out the rodents -- that's not how nature works, she seeks balance, not destruction. The owls will control rodents, keeping their numbers in manageable proportions and preventing an area being overrun by sudden plagues of the pests. Effective trapping and preventive measures will do the rest.

There are some problems with owls -- or rather not with the owls themselves but with the people. People are often frightened of owls, especially superstitious people. This applied to virtually all Europeans in the past, and some still feel that way today. The owl is an evil omen, a symbol of death and bad fortune. Its eerie, silent flight, its white face appearing suddenly from nowhere in the dark, and the terrifying screech it makes help to explain the worldwide superstitions about owls.

Workers on a rodent control project in East Africa setting up perches and nestboxes for owls were surprised by a highly negative reaction from the local communities -- to them owls were evil, the servants of witches, bringing bad luck and making the children ill. The problem was solved by involving the farmers in the program, with project staff explaining the aims and benefits of the work and giving information on owl biology and ecology. The rats were soon seen to be definitely worse than the owls. Now the nestboxes are up and have been very successful in attracting breeding owls.

You'll find everything you need to know about using owls to control rats at the resources below.

Resources

The Owl Pages
http://www.owlpages.com/

Owl Physiology, Anatomy of Owls -- what an owl is, and how an owl works:
http://www.owlpages.com/physiology/Default.htm

Owls in Mythology, culture and legends
http://www.owlpages.com/mythology/Default.htm

Owls in Lore and Culture
http://www.owlpages.com/articles/lore_culture/Default.htm

Barn Owl Headquarters
http://members.tripod.com/~Tommy51/

Using Barn Owls for Rodent Control
http://members.tripod.com/~Tommy51/aboutbarnowls.html

Nest Box Designs
http://members.tripod.com/~Tommy51/designs.html

Attracting Raptors with Perches
http://members.tripod.com/~Tommy51/perch.html

Artifical Perches for Raptors
http://www.rain.org/~sals/perches.html

How to Build Nest Boxes from off-the-Shelf Materials
http://www.rain.org/~sals/barnowl.html

Barn Owl Nestbox Plans
http://www.bsc-eoc.org/barnowlbox.html

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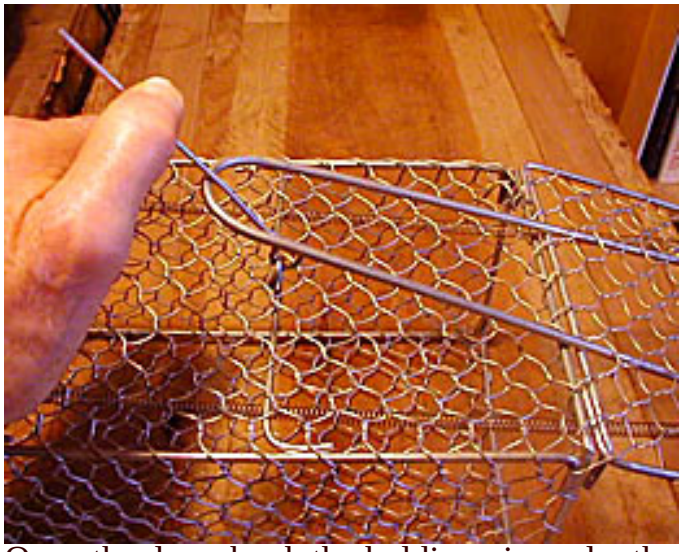
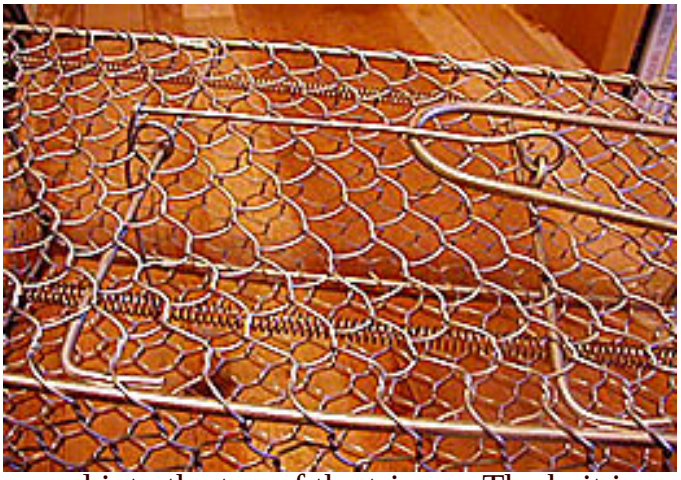
Chinese rat trap

-- How it works

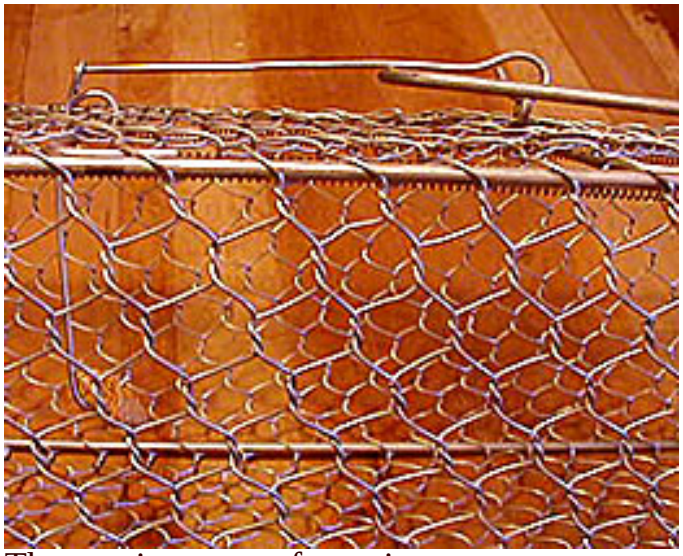
Measuring 12" x 6" x 4" (30.5 x 15.25 x 10 cm), the trap is made of a strong steel wire frame, covered with 1/2-in. chicken wire, with a spring-loaded door, and a baited trigger.



Open the door, hook the holding pin under the bar...

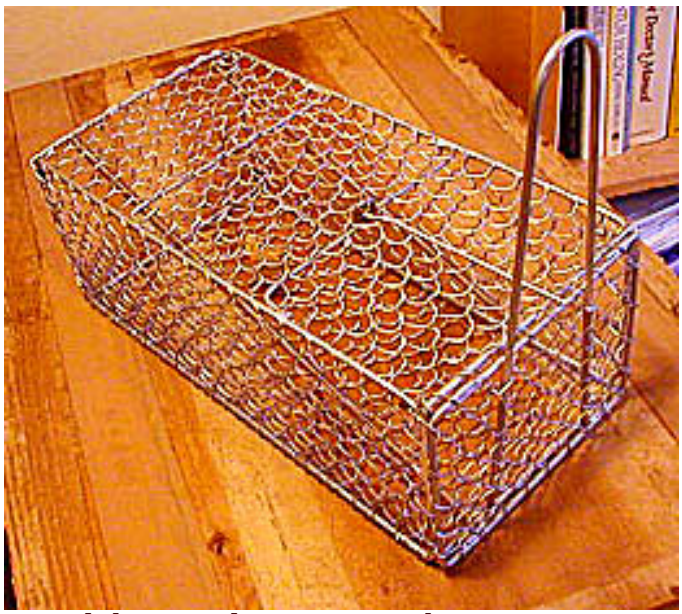


... and into the top of the trigger. The bait is set on the hook at the end of the trigger inside the cage.



The trap is now set for action.

The holding pin hooked into the top of the trigger. When the rat tugs at the bait on the hook below, the trigger slides off the end of the pin...



... and the trap door springs shut.

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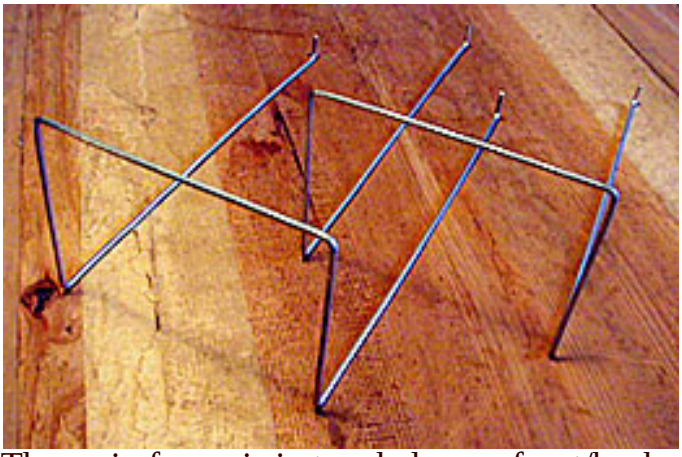
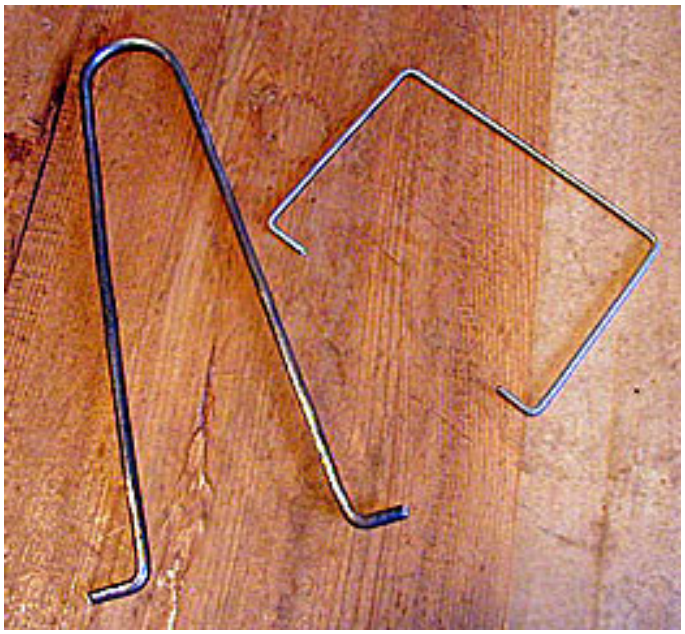
Chinese rat trap

-- How to make one

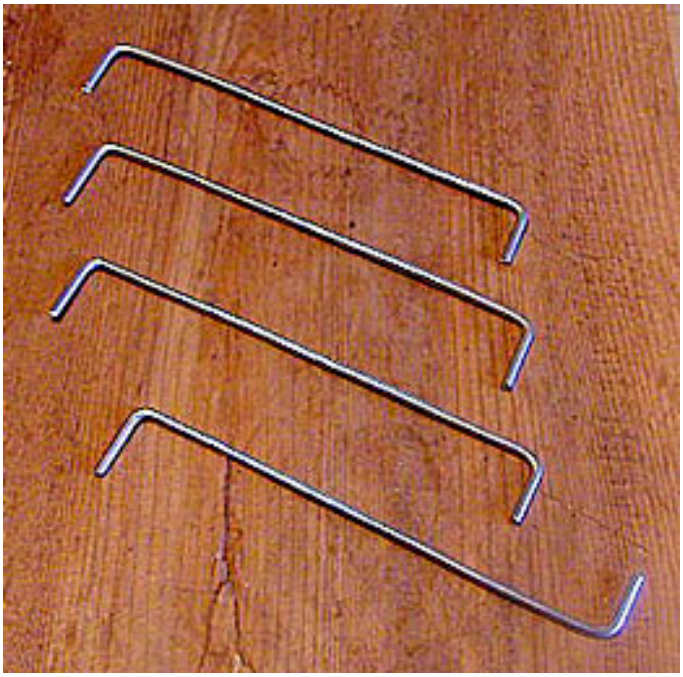
The parts



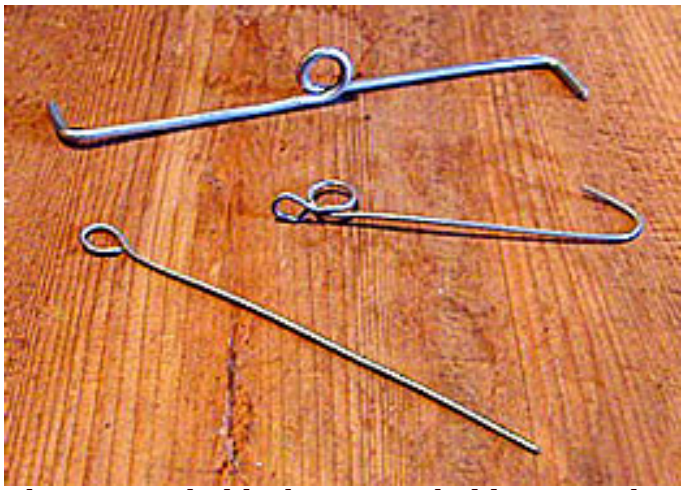
The main frame is in two halves -- front/back and top/bottom. Use 10-gauge wire (1/8", 3mm). (Gauges and measures are approximate.)



The square bit is the door frame, with the door bar. The bar is 10" high (25.5cm). The bar must be strong, use at least 8-gauge wire -- 5/32", 4mm.

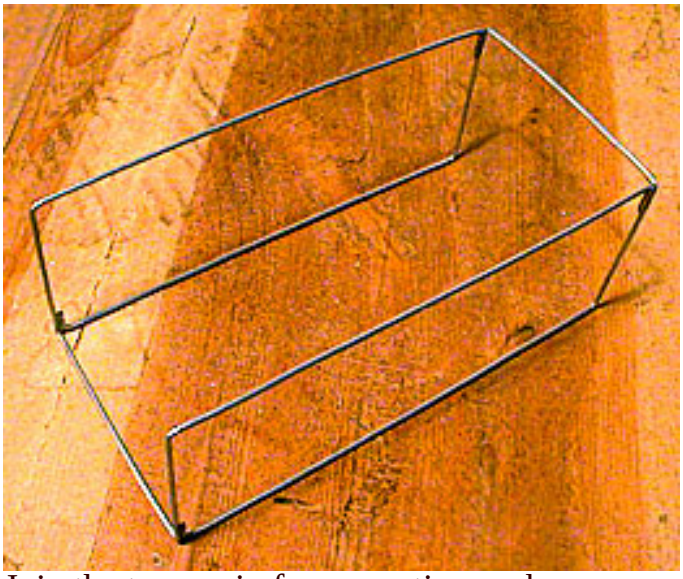


The top two are for the frame ends and for the door, the bottom one is a cross-piece, to hold the trigger.

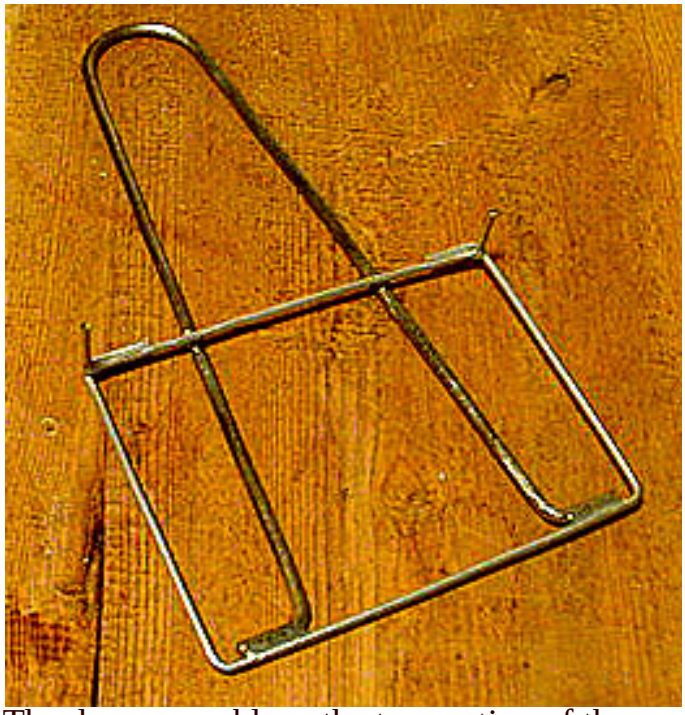


The top one holds the trigger holding pin; the trigger and the holding pin are of thinner wire, 1/16", 2mm.

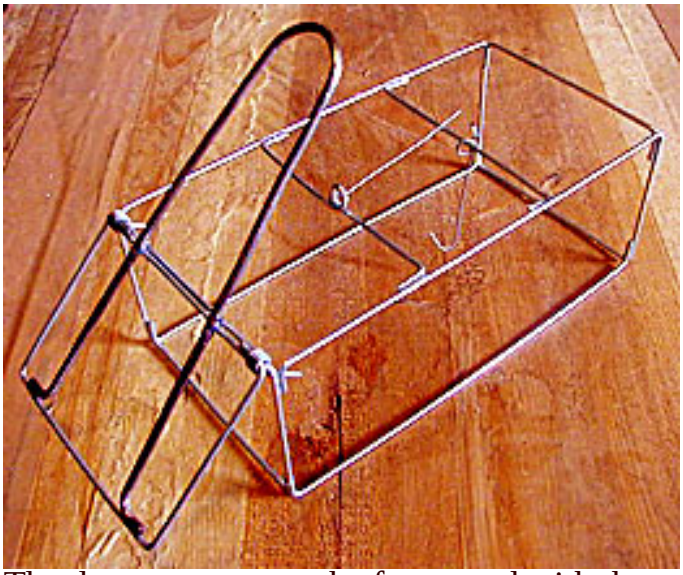
Assembly



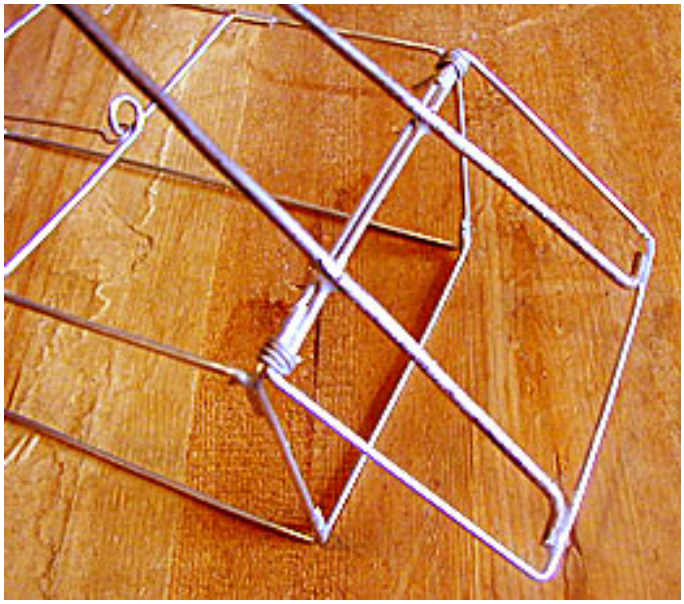
Join the two main frame sections -- braze and/or bind firmly with thin wire.



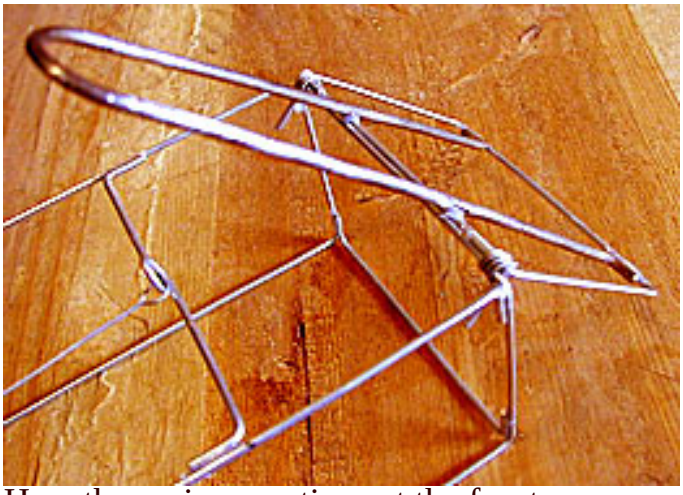
The door assembly -- the top section of the door frame is attached so that the two ends stick up vertically.



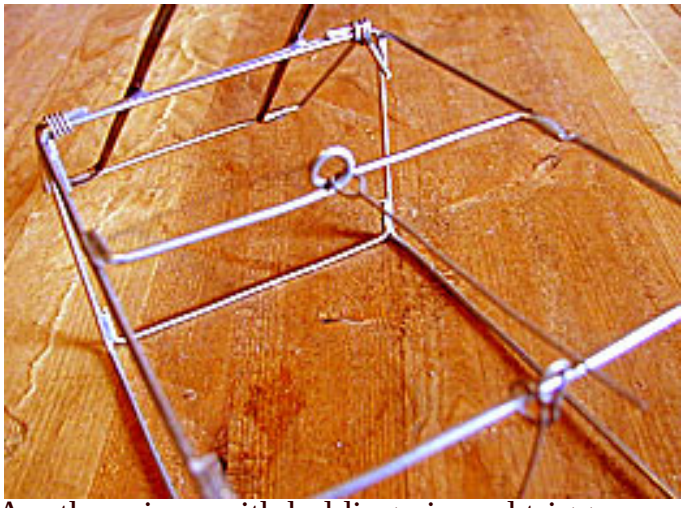
The door connects to the frame end with the joining section at the bottom. The two protruding door joining section ends go inside. Wire binding at each side acts as hinges.



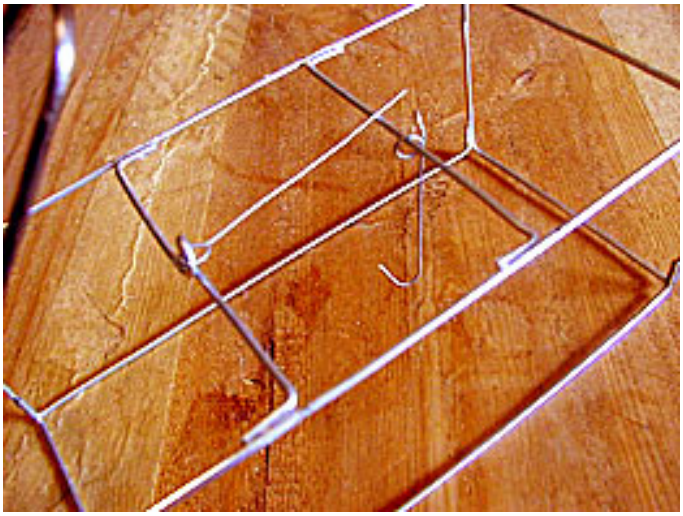
Another view.



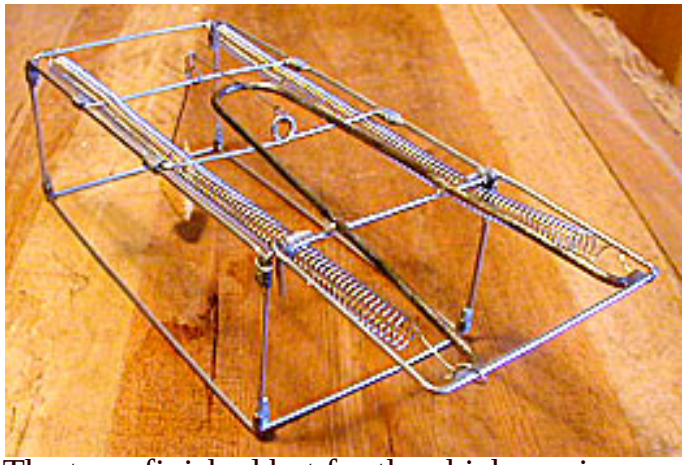
How the various sections at the front are joined.



Another view, with holding pin and trigger mounted to their cross-sections.

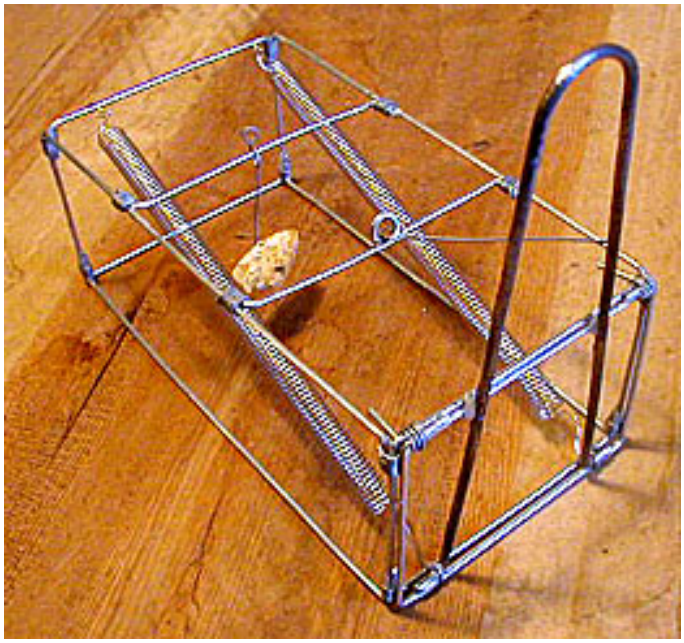


Another view of the holding pin and trigger.



The trap, finished but for the chicken wire covering. Baited and set. The springs are connected from the top corners at the back to the bottom corners of the door. Use strong springs, holding the door closed with a few pounds' pressure. Never underestimate the strength of a rat.

The trigger is sensitive -- any movement of the bait will spring the trap. We caught hundreds of rats with these traps, they didn't ever fail, and no rat ever escaped.



NOTE: The assembled frame and the door section should be covered with 1/2" chicken wire before the door is connected to the frame. We've left the chicken wire off here for the sake of clearer illustrations. Use thin wire to bind the chicken wire to the frame and door -- do a thorough job!

How to Make Springs -- online book, written "for the benefit of someone who has (or can gain access to) basic hand and power tools". Arranged in logical order presuming minimal knowledge of the metalworking trades or of springmaking, cross-linked to provide a forward path through the entire manufacturing process.
http://home.earthlink.net/~bazillion/intro.html

Bait

Nordic rats -- "sewer rats" -- are carnivorous, or omnivorous. Most "country" rats, the ones that damage crops, are mostly vegetarians, they like grains, tubers, fruit, as well as insects. For Nordic rats, a piece of cooked meat or fat is good bait. Take care, such bait may also attract cats. For country rats, we found any combination of wholewheat bread crust, raisins, peanut butter, fresh pumpkin or squash pith (including seeds) worked every time.

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An Effective Rat Trap

From the Rice-Wheat Consortium for Indo-Gangetic Plains [India]

Many farmers in the Indo-Gangetic Plains have taken to alternative tillage practices that reduce costs and raise productivity of rice wheat systems. Rice-Wheat Consortium for the Indo Gangetic Plains (RWC) has been at the forefront in promoting the widespread adoption of zero tillage and permanent bed planted methods. National scientists in the RWC are working with farmers to cut down burning of the crop residues (7-10 tonnes/hectare) predominantly the rice residues, producing 9-13 tonnes of carbon dioxide. Leaving stubbles on the surface, rather than burning is well known to provide a better habitat for the beneficial insects to proliferate is yet to be quantified. With the Pantnagar Zero Till Machine with chisel or inverted 'T' type openers it is now possible to establish a succeeding wheat crop in fields with anchored residues of the previous rice crop. The zero tillage method of wheat establishment has become very popular in the Indo-Gangetic Plains and already a hundred thousand hectares of wheat crop has been planted with Zero Tillage methods in India and Pakistan.

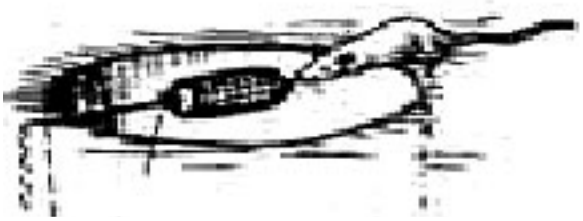
Several farmers recently have brought to the attention of the scientists the rat menace to the wheat crop established with zero tillage method with rice residues left on the surface.

Scientists have observed the rat population more in the fields that are in the vicinity of sugarcane fields. They ascribe the increased infestation of rats in zero tilled wheat fields to the 'migratory' phenomenon. Rice stubbles provide good hiding for the rats, scientists are studying this new concern. Chemical control measures are effective but expensive and time consuming. (Ground Cover, Vol 1, 1998).

Nick Dexter has reported a simple and effective rattrap widely adopted by the Zimbabwe farmers for control of rats. Nick Dexter says that he caught 934 rats with 9 traps in 21 days. Mr. Shekhon, who worked in Namibia and now with the Punjab Agro Industries, says that he tried the trap in Sangrur and it works very well. It is very simple to make the rat trap.

To make the trap you need a 20-litre bucket or large clay pot, which holds water. Bury this in the ground near known rat holes or leading sites.

Take a dry maize cob and cut off the ends. Push through it a thick wire, which is one metre long. Make sure the cob can spin freely. Fasten the cob in position in the center of the wire.



Bend the wire as shown and push firmly into the ground on either side of the bucket. Put a depth of 15cm of water in the bucket.

Each evening, coat the corn cob with peanut butter, wetted flour or some other kind of food which will stick to the cob.

Remove drowned rats each morning. The trap works best during the new moon.

For more information: See Ground Cover, Volume 3, No. 1, 1998

Rice-Wheat Consortium for Indo-Gangetic Plains
http://www.rwc-prism.cgiar.org/rwc/index.asp

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springs
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treatment
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wells -- tube wells, dug wells

... and all the rest of life...

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Kings off the road

Journey to Forever's 1973 Land Rover Series III lightweight

There was a golden age of 4x4 go-anywhere vehicles that lasted maybe 20 years, from the early 1960s to the early 1980s. After that came such innovations as style, comfort, air-conditioning, computerized controls, electric windows -- and status, sex-appeal, and all the other ploys used to sell modern cars. In other words, marketing.

It all just gets in the way of the job they're supposed to do. But what job are they supposed to do? In fact (with honorable exceptions), most 4x4s or SUVs (Sports Utility Vehicles) sold today never go off the tar, never get muddy, never get their beautiful paint-jobs scratched.

1999 Land Rover Freelander

The marketing men had noticed that a large proportion of the 4x4 market didn't know what all those other gear levers were for, and didn't care either. And they probably also noticed that it's just not good marketing practice to build cars that last forever. So function took second place to image.

We're only interested in function. Anything much less than 20 years old probably just isn't tough enough, versatile enough, dependable enough or fixable enough for Journey to Forever.

Again there are exceptions, like the Steyr-Daimler-Puch Pinzgauer and the Mercedes-Benz G-Wagens and Unimogs. In fact these are all golden-era vehicles, not really exceptions at all -- the Pinzgauer and the G-Wagen both date from the 1970s (they've been steadily developed since then rather than changed), while the Unimog goes back more than 50 years (and has also been developed rather than changed).

Other new models do perform well off-road, and on the road too, but they have things like newfangled computerized electronic engine-management systems that you just can't adjust with a screwdriver when you're a thousand miles from anywhere.

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You don't need a million-dollar workshop full of electronic equipment to diagnose, adjust or repair a Series III Land Rover, a Nissan Patrol G60 or a Toyota FJ40 Land Cruiser. You can fix them yourself. Mercedes has kept the 461 version of its G-Wagen simple for just that reason.

Toyota FJ40 Land Cruisers (from dirttrack's cruiser page)

1999 Toyota RAV4 Max

Another important factor is that the old, tried-and-trusted 4x4s were manufactured with much lower eco-costs than most vehicles being made today, even without taking their much longer useful life into account.

We think there are only six vehicles which fit our specifications, and only three of them are still being made. There are other fine vehicles, but they are too rare or lack the support to be practical for a project such as this.

Steyr-Daimler-Puch Pinzgauer
Mercedes-Benz G-Wagen
Mercedes-Benz Unimog
Land Rover Series III (out of production)
Toyota FJ40 Land Cruiser (out of production)
Nissan Patrol G60 (out of production)

See also **The best car in the world**

Steyr-Daimler-Puch Pinzgauer

In some ways the little Haflinger is the most capable of all 4x4s. The Austrian makers, Steyr-Daimler-Puch, went in the opposite direction to all other 4x4 manufacturers -- they made it as small and light as possible, and built in some of the best 4x4 engineering to be found.

Haflinger (Haflinger Club)

Basically it was built to take four Austrian soldiers up a mountain -- any mountain. Haflingers will go almost anywhere.

They're tiny -- four men can pick one up, which helps if you actually do manage to get it stuck.

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It has a 54" wheelbase, a 646cc two-cylinder air-cooled gasoline engine, portal axles for high ground clearance, very good approach and departure angles, a solid gearbox and front and rear differential locks, which means that even if only one wheel is in firm contact with the ground you'll still keep going.

Pinzgauer 716M 4x4

Haflingers were built from 1958 to 1974, and succeeded by the muscular Pinzgauer, very similar but much bigger.

Pinzgauer 718M 6x6

Pinzgauers are 4x4s or 6x6s, with a payload of 1.5 tons or more, very tough and very well-engineered, and they can handle virtually any terrain. They have a unique flexible tubular frame which is part of the secret of their agility.

To the chagrin of Land Rover fans, the British Army's Land Rovers have been replaced by the far more capable Pinzgauers.

The earlier models had 2.5-litre 4-cylinder air-cooled engines, later ones 2.4-litre 6-cylinder water-cooled Volkswagen turbo-diesels. From 2002 the Pinzgauers will be fitted with new and more efficient Euro III engines, a high-torque industrial variant of Volkswagen's popular 2.5 litre, 5-cylinder turbo inter-cooled diesel engine. In trials the new-engined vehicle has proven as quick off the mark with a full payload as the current model is unladen.

Unlike most of our Appropriate Technology vehicle choices, the Pinzgauer is still in full-scale production. In June 2000 production and future design of the Pinzgauer moved from the Steyr-Daimler-Puch plant in Graz, Austria under licence to the United Kingdom under the control of the

privately-owned company Automotive Technik, which supplies Pinzgauers to the British and other armed forces and worldwide.

Pinzgauers are a bit smaller and lighter than Unimogs, but just as powerful, faster on the road and at least as capable off it.

Haflinger Club
http://www.ccc.nottingham.ac.uk/~ppzcad/haf.html

Haflingers go anywhere -- Peter Fronius' Haflinger site
http://members.eunet.at/peter.fronius/bilder_e.htm

Pinzgauer All Wheel Drives
http://www.4wdonline.com/Steyr/Pinzgauer.html

Automotive Technik, UK
http://www.pinzgauer.uk.com/

Mercedes-Benz G-wagen

The Mercedes-Benz Gelaendewagen (cross-country car), or G-wagen, went into production in 1979, following five years of development by Mercedes and Steyr-Daimler-Puch (see below). It's a blocky, functional beast a lot like a Series Land Rover -- with the difference that it's undergone continuous development and is still very much in production, with Mercedes guaranteeing production for NATO up to 2025.

The G-wagen has gone through a series of model-changes and engine configurations, but the basics haven't changed -- this is still a very capable, very functional off-road vehicle. G-wagens seldom get stuck, and, unlike the old Series Land Rovers, they're fast, and they're comfortable.

They're used by 63 armies around the world, most recently the US Marine Corps. They're also much favoured by off-roaders and expeditioners, with a reputation for sure-footedness and reliability.

US Marine Corps G-Wagen

They come in short- and long-wheelbase versions. Engines are either gasoline and diesels, ranging from 4-cylinders to V6s and big V8s rated at up to 300 hp. Later models have front, rear and centre differential locks, manual or automatic 5-speed gearboxes with high and low transfer and permanent 4-wheel drive. Two basic versions -- the 461, a workhorse, and the 463, with more options, more luxury.

Everything about the Mercedes G
http://www.g4rce.net/

The G-wagen
http://www.vinthers.dk/AboutGwagen.htm

Mercedes Benz G-wagen
http://www.4wdonline.com/Mercedes/Gwagen/1990s.html

Mercedes-Benz G-Class
http://www.mercedes-benz.com/e/cars/g-class/default.htm

Mercedes-Benz Unimog

Unimog S equipped for an expedition (GT International)

This is what one authority says about Unimogs: "The Unimog has achieved an enviable reputation for reliable operation and agility in the most inhospitable terrain. The Unimog offers mechanical reliability unknown to its competitors. There is little requirement to carry extensive spares even on long-distance travels. It is virtually unknown for a Unimog to suffer serious mechanical damage and consequently only routine maintenance items need be carried as well as perhaps an additional spare wheel." (Westfield 4x4)

Unimogs can run any kind of machinery a tractor can run, three

machines at a time with independent controls, driven off the front and rear PTOs (Power Take-Offs) and the hydraulic system, with winches front and rear and on the side too if you want, including hydraulic winches that can be used as cranes.

Unimogs just keep going (Westfield 4x4)

There are many Unimog models, from light (relatively) through medium-weight to heavy trucks. A favourite for expeditions is the U-404 Unimog S, first introduced in 1956 and phased out in 1980.

These old Unimogs also last forever -- most are still running, as good as new. Parts are still available, and Mercedes-Benz has dealers in most countries. Many parts are interchangeable with other Mercedes models.

Steve Spence's Unimog pages:
http://www.webconx.dns2go.com/unimog.htm

Westfield 4x4 -- Unimog S:
http://www.west-4x4.demon.co.uk/page3.htm

Unimog Network International:
http://www.unimog.net/

Mercedes-Benz:
http://www.mercedes-benz.com/e/ecars/unimog/default.htm

UNIMOG -- A German Legend:
http://www.unimog.net/articles/schramm/

Land Rover Series III

See **The workhorses** for details of the Journey to Forever Land Rovers. Land Rover stopped making the Series models in 1985, but they're still being made by Santana in Spain, and in Iran. Santana continued developing the Series models, producing a Series IV, with such refinements as disc

New model PS-10 from Spain

brakes, an overdrive, parabolic springs and a 3.4-litre six-cylinder engine.

The company recently released a new model, the PS-10, based on the long-wheelbase 109" Series III. More photographs and details: http://www.ticonsole.nl/santana/ps-10.htm

But it was reported early in 2001 that Santana was having financial problems and production of the PS-10 could soon end.

The Land Rover Page:
http://regiments.org/rover/

RoverWeb:
http://www.off-road.com/RoverWeb/

Toyota FJ40 Land Cruiser

Toyota FJ40 in Brazil

Toyota is said to have copied the Land Rover when it made the first Land Cruisers, and maybe they did, but the two vehicles are very different.

Like Series Land Rovers, the FJ40 has had 40 years to prove its mettle in tough conditions all over the world. Also like Land Rovers, their owners love them. They also come in two sizes: the FJ40 short wheelbase, and the FJ45 long wheelbase.

The new Land Cruiser 100

And like Land Rover, Toyota stopped making the FJ40 in the early 1980s -- later Land Cruisers are tough and capable, but very different. However, the FJ40 is still being made by Toyota in Brazil -- virtually the same vehicle. It's called the Toyota Bandeirante, and still comes in two sizes. See:
http://4wd.sofcom.com/2000/000110-Bandeirante.html

But production of the Bandeirante was due to end late in 2001, with about 100,000 Bandeirantes having been built.

Toyota Land Cruiser 40/45 Series:
http://4wd.sofcom.com/Toyota/40.html

See also **Death of a Toyota** (Keith Addison), and **Death of a T*y*ta**

Nissan Patrol G60

Patrol G60 -- Picture by www.4wdonline.com

The Nissan Patrol was born in 1960. Still in production today, this is one of the longest running production models in the world. The G60 series was produced in short, medium and long wheel-base versions. Like the Toyota FJ40 Land Cruiser, it was prompted by the high sales of the civilian version of the US Army General Purpose Vehicle (GP -- Jeep) and the British Land Rover.

The Patrol had a reputation for simplicity and general toughness, ideal qualities in such vehicles. It had a 3-speed manual transmission and 2-speed transfer case with part-time four wheel drive. The motor was a rugged 6-cylinder 4-litre in-line unit which seldom needed repair -- it was said to be "bulletproof".

The new Patrol GR doesn't mind a bit of water

The G60 went out of production in 1979, replaced by newer models. But the old ones don't die easily, many of them are still around, and much cherished by their proud owners. The new ones are also tough beasts, capable off-roaders, mostly with powerful diesel motors.

A version of the G60 is still made in India for India's military.

Nissan Patrol G60
http://www.4wdonline.com/Nissan/60.html

Nissan Patrol 60
http://www.4wdonline.com/Nissan/60/1960s.html

Nissan US
http://www.nissandriven.com/

Nissan Europe
http://www.nissan-4x4.com/

Project vehicles -- the workhorses

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Backpack stove

Home Made -- Lightweight Backpack Stove

Here's how to make a camping stove for your backpack that weighs just about nothing and takes up hardly any space.

These little stoves are great -- they're fun to make and it only takes a few minutes. Not just a toy -- they really work! They put out a hot ring of blue flame like a gas stove and hold enough fuel for about 15 minutes -- so if you're cooking something that takes longer than that, better make two so you can alternate them to keep up the heat.

All you need is a couple of aluminium soft-drink cans, some perlite, a wire coat-hanger and a bottle of denatured alcohol (spirits, usually dyed purple).

Invented by: Unknown.
Construction directions by: LaMar Kirby -- Utah Lake District, Orem Ut., US

What you'll need

Parts List

- 2 Aluminum soda cans (soft-drink cans or beercans)
- 1/4 cup of perlite (found in the gardening department)
- Wire coat hanger
- De-natured alcohol (found in the paint dept. or boating supply)

Tools

- Scissors

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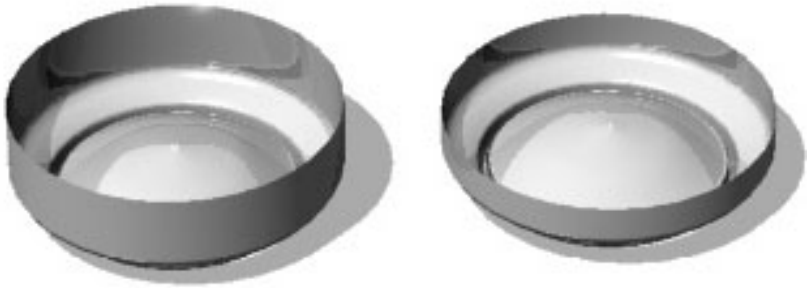
- Drill
- 1/16" (2 mm) drill bit
- Wire cutters

Step 1

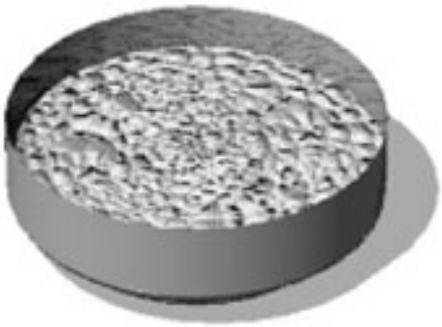


For the base, neatly cut one can about 1-1/2" (3.5cm) from the bottom. For the top, cut the other can about 1" (2.5cm) from the bottom.

Step 2

Drill a number of holes (18-30) around the edge of the top and in the center as shown; use a 1/16" drill bit.

Step 3



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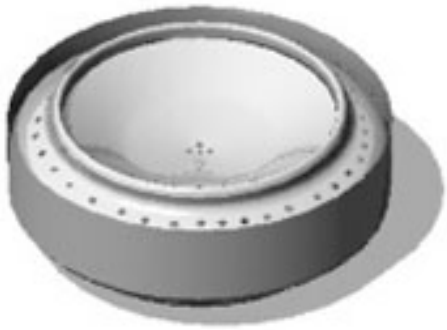
Fill the base with perlite, just more than half full.

Step 4

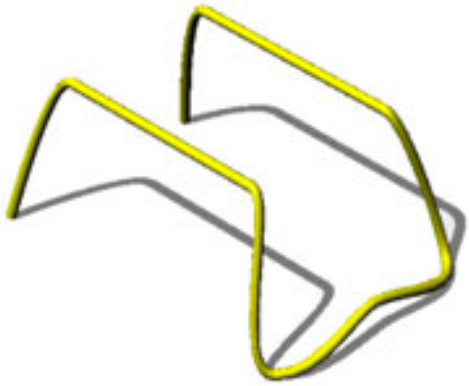
Make 6-8 vertical cuts around the top. Make the cuts up to but not over the rounded edge. Slowly press the top into the bottom. (A small board can help make it even.)

Step 5



Fill the stove about half full of alcohol. Light the burner by slowly moving a match or lighter over the edge of the burner. Note: If it does not stay lit, tip the burner up to leak some fuel into the rim and relight. Hold it until it stays lit or gets too hot.

Step 6



Cut and straighten a coat hanger. Use fine sandpaper to remove any paint or coating. Bend the coat hanger wire (or any large gauge wire) into a shape that will hold a pot a few inches above the burner (see the example). Note: with a little imagination you can create a number of stove bases.

That's it!

If you have any experiences that will improve this design please let me know.

Email:glkirby@usa.net
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Scott Henderson's **Pepsi Stove**
http://wings.interfree.it/html/Pepsi.html

The Home Made Stove Archives
http://wings.interfree.it/index.html

SuperShioshio lives in Yokohama in Japan, he's a mountaineer and he collects backpack camping stoves. "I seem to be attacked by stoves," he says -- he has more than 200 of them, stoves of every possible type, all on display at his website.
http://www.asahi-net.or.jp/~we2a-sod/index.htm

See also **Hobostove**, **TrailStove**, **Volcano kettle**

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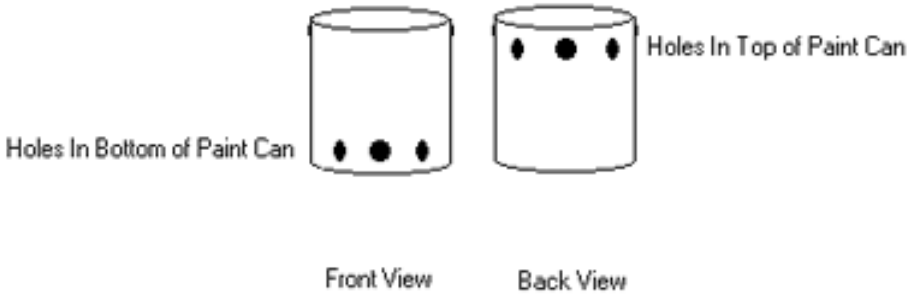
The Hobo Stove

Take a gallon paint can (exact size not important -- experiment).

Cut holes in sides of can as below:



Put anything combustible in and light it up.

The air flows in the bottom hole, and the aerodynamics of the can suck the exhaust out of the top holes. This forms a vicious through draught, and the fire burns almost white hot in a strong wind! It also uses very little fuel. Fire temperature can be controlled be turning can away from the wind a bit, or by obstructing the inlet hole.

Put a pan directly on the top of the can without the can lid (unless you are very fussy about carbon deposits on your pan) for maximum heat transfer. Or to bake, put lid on can, and baking receptacle on lid. Alternatively use a large lidded tin, like a biscuit tin, directly on the can, supporting the item to be baked above the bottom of the tin, so it bakes in the distributed temperature of the tin rather than the direct heat on the base.

These things are unbelievably effective, dirt-cheap and fun to make. You can easily make one on the fly with a Swiss Army knife and a tin you pick up. You will probably find yourself making lots of different designs just for the hell of it!! They are also useful in that you can burn up your camp rubbish to cook your next meal!

TrailStove

"The camp stove for the smart backpacker" -- an improved Hobo Stove -- powerful, burns wood, not propane, lowest pack weight of any stove on the market (only 15.3 oz).

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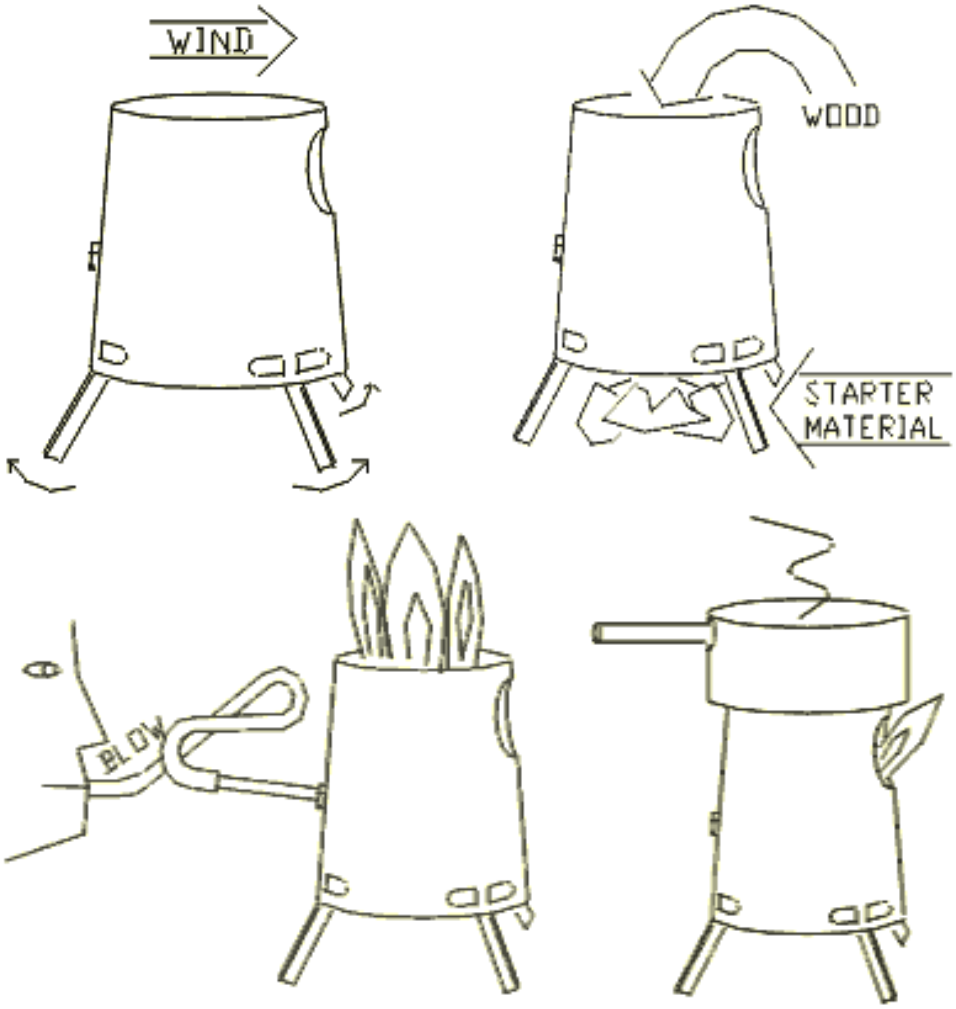

Full information:
http://www.trailstove.com/details.html

Volcano kettle

"My father had something called a 'volcano kettle' back when he was prospecting in the '50s which was an incredibly efficient way of boiling water (two good mugs of coffee from one sheet of newspaper). I found it a year or two ago and use it regularly when camping. It is a simple water jacket boiler. The whole thing is a cylinder about 40 cm high with a diameter of about 15cm and is made from aluminium (this one was spun into shape but I have successfully made one out of 6inch and 2inch aluminium irrigation tube). The unit works best with direct flame rather than coals (newspaper, twigs, leaves) and there is absolutely no comparison to gas -- it holds about 2 litres of water and I can have coffee within 2-3 minutes while people using gas rings have to wait about 20 minutes for the water to boil. The secret of operation is the large area directly exposed to the flame and the fact that the flame is still burning in the chimney (it looks really spectacular at night -- just like an actual volcano)."

-- From Ian Bennett, Zimbabwe

Here's a commercial version, the **Kelly Kettle**, with a "how it works" and a Shockwave animation -- "With the optional grate & pan, you can toast or cook a light meal! For boiling water it is the ultimate camping stove!"
http://www.y2k-millennium-supplies.co.uk/wood_burn/index.html

See also **Backpack stove**

Scott Henderson's **Pepsi Stove**
http://wings.interfree.it/html/Pepsi.html

The Home Made Stove Archives
http://wings.interfree.it/index.html

SuperShioshio lives in Yokohama in Japan, he's a mountaineer and he collects backpack camping stoves. "I seem to be attacked by stoves," he says -- he has more than 200 of them, stoves of every possible type, all on display at his website.
http://www.asahi-net.or.jp/~we2a-sod/index.htm

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PicoTurbine

Pico (pee'ko) very small
Turbine (ter'bine) a motor driven by curved vanes

A great energy project! PicoTurbine is a miniature, 8" (20 cm) high, wind-driven power generator, producing electricity from a direct-drive, single-phase, brushless, permanent magnet alternator.

With adult supervision, PicoTurbine can be assembled by children as young as 10 years old, making it an excellent project for renewable energy education.

PicoTurbine in action (Home Power #71, June-July 1999)

The entire project costs only a few dollars, and uses commonly available materials. Midori made one out of a pencil, a wire coat-hanger, a bit of wood, an old CD, some paper and cardboard, four magnets, some other bits and pieces, and these free plans and directions:

PicoTurbine Renewable Energy
http://www.picoturbine.com/

Or you can buy a special kit at the same site (also parts, bigger models, other projects).

"The PicoTurbine can produce 1/3 watt -- that's a lot of power when converted to education!" says the designer, J. Stephen Pendergrast. More advanced versions the same size can produce a full watt, but are more challenging to build.

The PicoTurbine site has general lessons on wind power and renewable energy. Teachers' guide, classroom experiments and activities.

The project includes lots of challenges for more advanced students, for instance DC experiments (kit available), and blade design: the blade offset can be increased or decreased, or the shape altered, the results tested and compared -- an excellent

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PicoTurbine (Home Power #71, June-July 1999)

science fair project.

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Crystal radio

Crystal radios don't even need a power supply -- they're powered by the radio waves broadcast by the radio station. You can build one for only a few dollars.

Building them was a craze in the 1920s, and again in the 1950s, and now it's happening all over again.

Crystal sets are endlessly fascinating because of their simplicity and their complexity -- they contain so few parts yet exhibit so many concepts. Crystal sets are a great tool for teaching, and a superb hobby.

The crystal radio was discovered in 1901. It is still the basis of modern-day radio and communications equipment and lives on in a wide variety of radio systems.

You can make a crystal set out of almost anything -- any small box, or just a bit of wood, or a frisbee or a deodorant dispenser (actual examples), or these (recommended for beginners):

A **loop crystal radio** using computer ribbon cable -- "Perhaps my favourite design," says low-tech guru Doug Edwards. Doug's crystal ardio pages are now hosted at Journey to Forever. See:

Dr Duggee's Crystal Radio
Radio plans page
Ribbon cable radio plans

Quaker Oats box crystal set:
http://www.midnightscience.com/project.html

Cigar Box crystal radio set
http://www.midnightscience.com/cigar.html

The **Crystal Radio Society** (the Xtal Set Society) has books, plans, parts, even kits, and a journal. The society was started in 1991 as amateur interest rekindled in crystal radios -- for the third time. Also on online forum, history and projects.
http://www.midnightscience.com/

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Useful **FAQ** and other resources from the Crystal Radio Society at its Science Fair Projects and Parents & Teachers Page:
http://www.midnightscience.com/sciencefair.html

A miniature crystal radio with ferrite rod tuner, by Doug Edwards

Good set of **links** to other resources on crystal radio, radio history and radio collections, headphones, amateur science and more.
http://www.midnightscience.com/links.html

Broadcast Timeline -- the history of broadcasting, radio, television and electronics (Richard M. Patricia, Warren County Technical School, US):
http://www.webcom.com/radioweb/educate/timeline.html

Scott's Crystal Radios
http://members.aol.com/scottswim/index.html

Crystal Radio Resources
http://www.thebest.net/wuggy/

Bizarre: Crystal radio
http://home.houston.rr.com/molerat/crystal.htm

Bizarre Foxhole radio -- Foxhole and PoW built radios: history and construction
http://home.houston.rr.com/molerat/foxhole.htm

Rap 'n Tap Discussion Group at the Xtal Set Society
http://www.midnightscience.com/rapntap/default.asp

radiokits Discussion Group -- for building radios from kits or from scratch (homebrew): shortwave, crystal sets, AM/FM, VHF
http://groups.yahoo.com/group/radiokits/

One modern drawback to making crystal radios is that it's not as easy to listen in as it was in the old days. The design of **headphones and earphones** has advanced and cannot pick up the simple crystal signal, which old-style phones had no trouble doing. But the Xtal Set Society now stocks crystal earplugs, capacitors and other parts.

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http://www.midnightscience.com/catalog5.html

Headphone Repair Page at Scott's Crystal Radios
http://members.aol.com/oldradjo/repair.htm

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What to do with a cardboard carton

Which is best?

1. Throw it in the garbage
2. Send it to the waste-recyclers
3. Turn it into a solar box cooker
4. Use it instead of an oven to bake sweet potatoes
5. Turn it into a composter that finally composts itself -- and grow a tree in the compost you make
6. Feed it to compost worms (see **Vermicomposting** page)
7. Make a Growing Column and grow 50 vegetables in it
8. Hatch 3 dozen eggs in it -- make an incubator
9. Make an armchair
10. Build a house.

Garbage

Most cardboard boxes end up in the garbage dump:

- 9% of the average urban garbage dump consists of cardboard boxes
- 1 ton of cardboard boxes is the equivalent of 17 trees
- Recycling one ton of cardboard saves over 9 cubic yards of landfill space
- Recycling 1 ton of paper uses 7,000 fewer gallons of water, saves 35% of the water pollution and 70% of the air pollution produced in making new paper, uses 4100 KWH less energy, and saves 390 gallons of oil
- In Hong Kong, recycling boxes also helps to support the poor old people who make a living collecting boxes for the recycling presses.

Recycling

So it's better to recycle cardboard boxes. Or is it?

-- November 19, 1998: Hong Kong's only newspaper-recycling company, Concordia Paper Ltd, collapses amid financial difficulties. Waste paper accumulates at the rate of 500 tonnes a

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day and more than 450 people lose their jobs.

"Even if the [recycled paper] market disappeared entirely, there would be no problem collecting an extra 2,000 tonnes of waste paper a day and taking it to the landfills." -- Deputy Secretary for Planning, Environment and Lands, Kim Salkeld, South China Morning Post

Find out what really happens to the goods you recycle! How can you do that? Find that out too! Ask questions, keep asking until you get the right answers. Don't just hand it over to someone else to take responsibility, take responsibility yourself!

Just as much to the point: do you use recycled paper? Does your family? Does your school? What about other recycled goods? See **Recycling facts**.

Solar box cookers

One of the best ways to use a cardboard box is to turn it into a solar box cooker. Recycling 60 or so cardboard boxes might save one tree, but one solar box cooker can save at least one whole tree all by itself, each year. Some people think solar box cookers can save the world, and they could be right!

Solar box cookers for schools
Solar box cookers
Solar cooker resources on the web

It takes three or four cardboard boxes to make a solar cooker -- not enough to use up your share of the supply. How many cardboard boxes is each person in your community responsible for each year? How would you find out?

Baked potatoes

So what can you do with the rest of your cardboard boxes? You could burn them, if you have a big enough and safe enough space to do so. Wasteful? What about greenhouse gases?

As far as greenhouse gases are concerned, when you burn a box, or anything made out of trees, you're not creating greenhouse gases, just recycling them. The CO2 released in the fire is reabsorbed by other plants and trees. CO2 levels in the atmosphere don't increase as a result.

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As far as waste is concerned, it depends what you do with the fire. First of all, cardboard boxes make a really fine blaze, though it doesn't last long. Second, when the blaze dies down, you're left with a very mild kind of charcoal, glowing softly with a gentle heat, and if you pile it all together in a fireplace made of a few bricks (you need a good, long stick for this), you can use it as an oven.

Baking potatoes in an oven takes half-an-hour at high heat -- and high power bills! Best keep them for the barbecue. But charcoal and wood fires are too hot for potatoes -- the outside gets charred, the inside's not cooked enough, the timing is critical, and the whole thing interferes with the coals you're trying to grill those chicken legs and sausages over. Better to bake the potatoes separately in another fire -- using cardboard boxes. It works much better -- yum!

Bake potatoes, sweet potatoes, yams, taro, squashes, Beach House-style

What you need:

- Some newspaper and a little kindling
- 3 cardboard cartons (eg potato boxes from the supermarket)
- foil
- a long stick
- some bricks, or a barbecue, or, best of all, an old car wheel
- a couple of square feet of wire netting
- an open space
- a bucket of water for safety's sake

Cooking time: anything from 25 to 40 minutes.

If you're using bricks or stones, make a square about 6" high with about 1 sq ft inside for the fire. Wash the potatoes (6-8 quite big ones) and wrap them up in foil (two thicknesses). Crumple up the newspaper pages, separately and not too tight, scatter some kindling on top. Set the newspaper alight. When it's all burning merrily, put the potatoes-in-foil in the bottom of the smallest carton and put the carton on the fire. When the carton's burning well put another carton on top of it, like a lid. Meanwhile the potatoes will fall through the bottom of the first box into the kindling. When the second carton's burning and before the whole thing starts to fall off the fire, put a third carton

over it, again like a lid. This makes a great fire! Stand by with the stick to help all the embers fall into the fireplace -- if you get it right, the whole thing should collapse on top of the potatoes. Put some wire netting on top to keep the embers and ashes in.

You can add a dash of the delicious sauce of moral self-righteousness by considering the environmental costs (pollution, global warming, acid rain, etc) if you'd baked all these yummy potatoes in the oven and used up all that energy.

Composting

Still got some spare boxes? Make a composter that finally composts itself. You need two boxes the same size, quite big ones, 18 inches square or more (they don't have to be square).

Open up the flaps at both the top and the bottom, tape the bottom flaps open so you can stand the box on them. Stand it on some sticks or anything you can find that'll keep it slightly off the ground, an inch or so is enough (it's important for compost to breath from underneath).

Scatter a few inches of old dead leaves or something similar in the bottom, they should be slightly moist but not too wet. (You need a lot of old leaves for this, and the drier the better -- collect them in autumn.)

Garden wastes that you can compost usually come in quite small amounts. So do kitchen wastes. You can use them both. For kitchen wastes, get a 2-gallon plastic bucket with a lid, drill a few holes in the bottom and stand it in a plastic tray. Again, put some dead leaves (dry ones) or straw or old hay or torn-up newspaper or cardboard in the bottom. Put your kitchen wastes in the bucket every day (avoid cooked food wastes and meat or fish until you get really good at this). When the bucket's about half full, or when liquid starts to gather in the tray, it's ready to empty -- don't leave it too long!

Mix the kitchen wastes up with about the same amount of dead leaves or more, and put it in the cardboard box. Add more dry stuff on top. Close the top flaps.

Dry stuff:
Dead leaves, shredded cardboard cartons (cut up into strips), shredded newspaper (tear it with the grain into 1" strips -- black ink is non-toxic, avoid glossy paper), shredded computer paper,

sphagnum **peat moss**, **coconut coir**, chopped-up straw, spoiled hay, yard clippings, dried grass clippings, sawdust, wood shavings (avoid treated wood). Mixed ingredients are better, add a small handful of soil per bucketful.

You can add any garden wastes at the same time. Leave them spread out somewhere dry to wilt until you're ready to empty the kitchen wastes bucket.

When the first box gets full, add the second box, taping the bottom flaps over the opened top flaps of the first box. When both boxes are full, start a new unit with two new boxes. After a couple of weeks, tip the first boxes over, empty them, mix everything up evenly, add more water if it's too dry, and put it back in the boxes again.

A few weeks later it should be finished. By now it should be dark, crumbly stuff. If it got hot during either stage, that is really hot, too hot to put your hand in, and it smells earthy rather than rotten, then you can use it in the garden straight away -- the plants will love it!

If it didn't get very hot, leave it under cover for a few months; keep it moist, don't let it dry out.

After a couple of cycles the boxes will be too rotten to use again; tear them up and use them with the dry leaves. You can use the compost to grow another tree! Or put it in a growing column (see below).

See **Composting resources for schools**.
See **Composting** pages.

Feed it to compost worms

Wriggly red worms turn food scraps and organic wastes into nature's best soil to grow more food -- and the worms love eating cardboard cartons (and newspapers). Classroom vermicomposting projects are great for teaching a wide variety of subjects.

See **Composting resources for schools** and **Vermicomposting** pages.

Growing columns

Make a column out of 1" chickenwire, 3ft high and 15-16 inches in diameter. You'll need 5ft of 3ft-wide chickenwire, allowing for a 1ft overlap. Fasten it with twists of thin wire. Line the inside with corrugated cardboard from cardboard boxes.

Stand it up on end, hold a 4"-diameter plastic plumbing pipe in the middle and fill the pipe with sand and stones (builder's gravel for concrete is ideal). Fill the rest of the column around the pipe with good soil, packed down enough to prevent it sinking too much later (but not too tightly -- don't compact it). Carefully remove the pipe.

Cut slits 2-3" long through the cardboard in a spiral going round the column from top to bottom. The spiral should go round the column 6 or 7 times, with 6-8" between the slits, making about 50 slits or more.

The sand and stone core is for watering -- water will sink right to the bottom and then spread out to the sides. After you've watered it it will sink a little; top up with more soil and sand.

Plant leaf vegetable and salad crop seedlings through the slits. Water every few days.

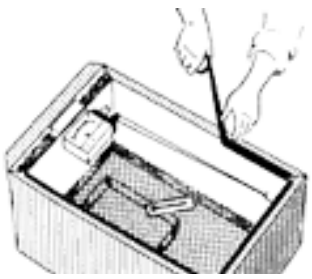
This gives a growing area of 12 square feet occupying a very small space. Make sure you put it where it will get enough light, or supplement natural sunlight with growing lamps.

You can make a few columns -- plant them about two weeks apart for a steady harvest throughout the growing season. Five will give an average family lots of delicious, fresh, green vegetables.

See **School gardens**.

Egg incubator

Make an incubator out of two cardboard boxes or plywood -- this online schools biology project uses commercial heating elements or light bulbs in porcelain sockets. Expect about a 50% success rate with 3 dozen eggs (commercial



incubators: about 80%). See Chickscope 1.5: Resources: From Egg To Chick: http://chickscope.beckman.uiuc.edu/resources/egg_to_chick/incubator.html

See **Poultry for small farms**.

Make an armchair

Corrugated cardboard is strong, especially double-thickness cardboard: this armchair by ReturDesign in Sweden will support anyone weighing up to 100kg. And it sells for US$175!
http://www.returdesign.se/intro.htm

This is a great class project: originality, creativity, and a new way of looking at ordinary things.

Experiment with different designs, see how structural strength can be reinforced. An Internet search for "cardboard chair" and "cardboard furniture" will give you more ideas.

More Swedish designs

Build a house

Recycled cardboard kits for low-cost housing and emergency relief

An award-winning new building system in Canada uses mostly recycled cardboard as its primary component. It is lightweight, inexpensive and strong enough to resist heavy snow loads and hurricane winds. These "Instant Houses" can be assembled by unskilled workers in as little as one day.

They're targeted at the longer term "temporary" housing market, including emergency relief, humanitarian aid, remote site

development, camps, and tourist cabins etc., where quick and easy transportation and set-up are required. But the manufacturers are planning to evolve the system into the "permanent" residential, utility and cottage markets, among others.

Recycling facts

- Recycling one tin can saves enough energy to run a TV for three hours.
- Recycling one glass bottle saves enough energy to light a 100 watt bulb for 4 hours.
- One 20-year-old tree makes 785 paper bags.
- Packaging accounts for more than 30% of your garbage.
- For $11.00 spent on groceries, $1.00 pays for packaging.
- It takes 17 trees to make one ton of paper.
- 11% of America's garbage is food waste, 9% is compostible.
- Recycling aluminium can reduce energy use by 95% with similar reductions in water and air pollution.
- Percent of energy saved by using recyclable materials instead of virgin materials:

  cardboard 24%
  newsprint 34%
  plastic 88%
  glass 5%
  aluminum 95%

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Sisters of silk
Hong Kong's Chinese Amahs

-- A social research and oral history project for Hong Kong schools to help capture a special part of local history before it fades away.

The Chinese amahs (domestic servants) first gained economic independence through the silk boom in the rural areas of China's Guangdong Province at the beginning of the 20th Century. When the silk boom ended, they formed sisterhoods, took anti-marriage vows, and devoted themselves to domestic service.

Now there are only a few of them left, and the fascinating history of these women and their unique way of life will soon be lost forever.

But children can gather much information from the older generation of their families, and from such details a history can be compiled.

The students will not only be contributing to Hong Kong history but will also build their own history resource instead of relying on others. This is a collaborative project for all levels of pupils.

The project will lead on to rural studies during our journey to see whether this home-based rural industry that boomed worldwide early last century, silk production, can provide sustainable rural employment, especially for women.

Subject areas:

- oral history
- civic education
- social research
- women's issues
- using personal and family networks
- ecology
- IT education

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Background

A hundred and twenty years ago much of China's Pearl River Delta north of Hong Kong was a vista of villages and hamlets floating on a sea of fishponds, with a few tiny fields in between.

Fifty years later the land had changed -- half the ponds had been diked, drained and filled with soil, and most of the new land was covered with mulberry trees, producing large crops of white mulberry leaves to feed silkworms.

Drawing by Christine Thery

Half the population was working in China's booming silk industry. And it was the women who harvested the trees, raised the worms and produced all the silk.

The women also did all the reeling, spinning the yellow cocoons into yarn on reels powered by a foot-treadle, working in their homes. There were also hundreds of factories dotted throughout the area, using steam-powered reels to produce silk for export, and all staffed by women. For the first time, rural women in the Delta were well-paid.

Many young silk workers used their new independence to opt out -- they refused to get married, swore oaths of chastity and moved out of their family homes into spinster houses or vegetarian halls.

Many formed sisterhoods, worshipping the chaste goddesses Tin Hau and Kuan Yin. They would even threaten collective suicide to protect one of their number from an unwanted marriage -- and sometimes carry out the threat.

But in the early 1930s the silk industry slumped in the world depression, and many of the women were thrown out of work. Streams of unemployed women silk workers migrated to Hong Kong and Southeast Asia, as labourers, and as mail-order brides, slave girls and prostitutes.

But many took their bonds of sisterhood with them and managed to retain their independence, staying single and working as family domestic servants.

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These were the famous Chinese amahs of Hong Kong, Singapore and other Southeast Asian centres, devout, down-to-earth and utterly dependable servants with a style all their own. They brought up generations of Hong Kong's most prominent sons and daughters, who will never forget them.

-- "I've worked for three generations in this family. I have worked for them for 50 years now" -- Leong Ah Hou

After a lifetime's service they would retire, using their savings to join a vegetarian hall and live out the rest of their days in peace with their sisters.

This highly personable segment of Hong Kong's culture and history has vanished in the last 20 years -- now "amah" means a Filipina maid.

But there are still some old Chinese amahs left, and some may still even be working for their families, old but capable, and much-loved. Retired amahs are still to be found in vegetarian halls in the New Territories and Lantau Island. A hall attached to a Taoist temple in Mui Wo on Lantau is one of the few places where you can still hear genuine pidgin English spoken.

Not all the women went to the halls. Round the corner from the Handmade Projects headquarters at the Beach House in Pui O on Lantau is a ruined farm where a retired amah named Lui Ying lived in a small cottage, growing vegetables and tending her fruit trees and the ducks swimming in the pond she'd made by damming a stream. There were even a few carp in the pond. She died in the late 1980s. Her grave is in the woods nearby, a peaceful scene.

Chat Suk, our neighbour at the Beach House, is 85, but he still doesn't need spectacles to read his newspaper. His mother used to raise silkworms in their village in Guangdong Province to help the family income. When he was a young boy in the 1920s he helped her gather mulberry leaves to feed the worms. He still has some cocoons -- he keeps them as a good-luck charm, a memento of old times.

There is an old Buddhist shrine on a mountainside in Lantau Island with a stone shrine-keeper's cottage beside it where an old woman lives. She was sold as a child in China and taken to Singapore as a slave girl, but she escaped and returned to Hong Kong. She's lived at the shrine for

the last 60 years. She has a really beautiful smile.

The project

Project goal:

- To compile a multi-media database chronicling these women, their origins, and their lives
- To publish the database on the Internet as an educational and general resource
- To use the database as an interactive Internet tool to gain further contributions so that the resource keeps expanding.

This is a multi-level and multi-disciplinary exercise, with the following components:

Library research

For secondary grades

- Research in local libraries and in libraries abroad, via the Internet, with students learning to use Internet search engines and research tools
- The project can be extended from Hong Kong, first to institutions in Guangdong and elsewhere in China, and globally: Chinese amahs went everywhere, to Southeast Asia, Sydney and San Francisco, while international scholars have studied China's silk boom in depth.

Social research

For all levels

- Question family and other networks to find people with experience of amahs or any information about them (all students)
- Follow-up all contacts (all students -- secondary students can assist primary students where needed)
- Collect and collate the information: contacts, anecdotes, photographs, documents, any information on any amahs still working or retired -- computer-based, this is the skeleton of the future database: secondary students will build it, all students should be able to use it
- Interview surviving amahs, with recordings, photographs and video (but only if it is felt that this won't intrude on the interview) (secondary students, requires learning interview techniques)

- Interviewers should attempt to cover the subjects' life experience, their feelings and beliefs about their chosen way of life, why they'd chosen it, including anecdotes wherever possible, along with contact details of employers or their relatives, any information on their relationship with their sisters (with contacts), religious aspects of their sisterhood sect, what they might know of earlier amahs
- Follow-up on material and leads gained in interviews
- All results constantly compiled and collated, along with library and other research results, linking the women to their backgrounds, to all other information about them, to each other, and to their origins, in a virtual community.

Subject areas covered

- Library research methods
- Integrated Internet research and collaboration
- Social research
- Information collection, collation and management
- PC database design, management and use
- Building a history resource
- Building an Internet resource
- Oral history
- Interview techniques
- Recording techniques
- Identifying and using networks in your own personal sphere
- Women's issues

Related projects

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Kids' crazes

School gardens

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Silkworms in a shoebox

Rearing silkworms in the classroom or at home

There are about a million known species of insects, and entomologists estimate that many millions more have not yet been identified, but of all these species, only one has been domesticated by man: Bombyx mori, the silk moth.

After nearly 5,000 years of selective breeding, silk moths have lost the ability to fly and cannot survive without humans.

Many of us wouldn't survive without the moths either -- many, many people around the world depend on the silk moth for their livelihood, from peasant farmers who grow the mulberry leaves the silkworms eat and poor rural women who rear the moths and produce the precious cocoons, to the fashion boutiques in the world capitals that sell the luxury silk garments and fabrics.

A hundred years ago the silk moth brought hundreds of thousands of peasant women in south China a new freedom they'd never had before when a world silk boom swelled demand, bringing prosperity to the women who raised the worms and spun the silk in their homes, and job opportunities for women workers in new local silk factories. (See **Sisters of silk -- Hong Kong's Chinese Amahs**.) A woman silk worker could earn enough to support a family of five.

Khemara's rural development program: this Cambodian village loom weaves silk for home use

Today silkworm raising is bringing independence to peasant women in Cambodia via the efforts of the Khemara NGO, the "voice of women in Cambodia", which has revived traditional Cambodian silk growing, weaving and dyeing in its work to empower women at the grass-roots level.

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By the time a silkworm starts weaving its cocoon it weighs 10,000 times more than when it hatched from its egg as a tiny creature less than two millimetres long, all from eating mulberry leaves.

Any other insect that attacked such a useful, multi-purpose plant as a mulberry like that would be a farmer's deadly enemy, the target of poison sprays and biological controls like killer wasps or bacterial diseases. But we treasure the silk moth, and it rewards us well -- today's silk industry is worth about $2 billion a year worldwide.

Annual world production is estimated at about 100,000 tons -- more than 600 billion cocoons. A single cocoon contains anything between 0.5 and 1.5 kilometres of thread.

The Chinese discovered the secret of silk about 2640 BC, and kept it a secret -- for nearly 3,000 years all silk came from China. But the secret escaped when sericulture spread to India in the 2nd century AD, and to Japan a few centuries later.

In the 6th century AD two Persian monks visited China and smuggled a few silk moths back to the West hidden in bamboo canes. These were the basis of the European silk industry for the next 1,400 years.

Today Italy is the major European silk producer -- the French industry never recovered from a plague in the 19th century which wiped out the worms. About 70% of world production still comes from China, and another 12% from India, with Japan, Russia, Vietnam and Brazil accounting for most of the balance.

Natural and "wild" silk from India

India produces several different kinds of silk, not all of them from the silk moth. These are **"Wild Silks"** such as Tussar, feeding on oak leaves, Eri on the castor-oil plant leaves and Muga on polyanthus leaves. Each of these produces different kinds of yarns. See About Silk from J.J. Exporters Ltd for more information.

Wild African silkmoths are being domesticated to generate valuable income for African farmers. Asian countries are no

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longer producing enough raw silk to satisfy demand but African farmers could reap the benefits of this market opportunity by supplementing their income with silk production, or sericulture. ICIPE (International Centre of Insect Physiology and Ecology), based in Nairobi, is providing farmers in Kenya and Uganda with the opportunity to produce valuable tussar silk from indigenous African silkmoths. The moths feed on Acacia trees rather than mulberries.
http://www.new-agri.co.uk/99-3/focuson/focuson7.html

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Resources

The **Khemara NGO** initiated the Cambodian Women's movement and supports women's empowerment in Cambodia. Read how the group is reviving Cambodian silk growing and weaving, and traditional natural dyeing methods. Well illustrated: from mulberry to silk worm, harvesting the silk, Cambodian Ikat dyeing, the loom for the weaving, Ikat weaving.
http://www.cambodia.org/clubs/khemara/cover.htm

Silk moths at a Khemara village project

Silkworm Raisers' Customs -- a description of traditional cottage craft silk raising in Zhejiang and Jiangsu provinces in China. Legends, folklore, taboos. "When a couple get married, the girl's parents will send the couple two young mulberries, two round shallow baskets of silkworms and silk clothes and bedding as a dowry. They hope that the bride will bring brisk business."
http://www.chinavista.com/experience/silkworm/silkworm.html

The **Silk Laboratory** at Shinshu University is working to preserve Japan's traditional silk technologies and develop them further to pass on to the younger generation. "Silk is a part of our Japanese daily life and culture." Many interesting resources here.
http://silk.shinshu-u.ac.jp/defaultE.htm

Information for **K-12 teachers** about raising silkworms in their classrooms. Comprehensive resource: teacher resources, eggs and equipment, raising silkworms, history, schedule, display case, silk thread and cloth, science questions. Entire website can be downloaded as text (1.7 MB) and printed out. Overview of the silkworm cycle with pictures, extensive links to more silkworms sites on the Internet.
http://www.pclaunch.com/~kayton/

Silkworm Rearing -- Center for Insect Science Education Outreach at the University of Arizona. Lesson plans, information sheets, rearing sheets, bibliography.
http://insected.arizona.edu/silkrear.htm

Rearing The Domestic Silk Moth -- Sericulum provides full instructions and supplies for schools, includes the company's Silkworm Cocoon Discovery Kit with cocoons, equipment and study guide; eggs, specimen moths, anatomical diagrams, literature.
http://www.sericulum.com/

How-to book from Sericulum

Mulberry Farms in California supplies silkworms and silkworm supplies -- live silkworms, silkworm eggs, baby silkworms, preserved mulberry feed for raising silkworms all year long. They also supply silkworms as food for pet reptiles. Email info@mulberryfarms.com
http://www.mulberryfarms.com/index.php?page=products

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Mulberry trees

A hundred years ago half the population in parts of south China was working in the booming silk industry. The land was covered with mulberry trees producing leaves to feed the silkworms.

Painting a mulberry bark Tapa cloth with traditional dyes in Papua New Guinea

This was an integrated and sustainable farming system, coupled with duck and fish production: the silkworm waste and duck droppings produced food for the fish in the ponds; once a year the fish were sold, the ponds drained and the fish waste and silt was used to fertilise the mulberry trees. Production rates were very high. (See below -- **Silk, rice and fish**)

Like most trees -- perhaps even all trees -- mulberry trees (Morus alba) have many further uses. In **"Tree Crops: A Permanent Agriculture"** (ISBN 0-933280-44-0, 1950), American researcher J. Russell Smith writes that mulberry trees provide high-quality harvest-free feed for pigs and chickens.

Mulberry leaves and fruit at the Journey to Forever organic garden

He quotes the case of a small farmer in North Carolina who kept pigs and claimed that one-third their weight was due to the mulberries falling from his trees -- about 625 lb of pork to an acre of "rather thin, sandy land with little care and no cultivation".

Russell Smith says mulberry trees are cheap, very easy to propagate, easy to transplant, they grow rapidly, start fruiting almost immediately, have a long fruiting season and don't need harvesting. The leaves can also be eaten as a vegetable and make a nutritious feed for dairy cattle.

Fruit yields are estimated at 4-14 tons per hectare. James A. Duke, in **"Handbook of Energy Crops"** (1983, unpublished), sees the

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mulberry tree as a source of energy:

Cleaning boiled mulberry tree bark to make shoji paper in Japan

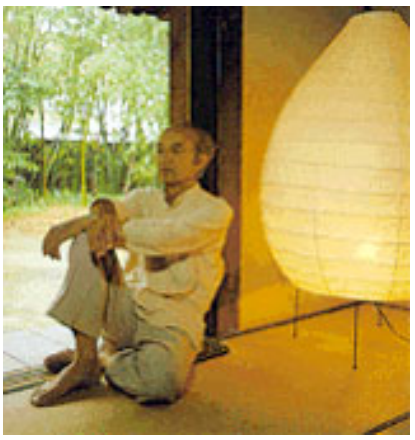
"Those of us who have seen solid coats [of mulberry fruits] on the ground realize that there is a lot of sugar there that could be converted to alcohol." He also cites work in South Korea on producing high yields of ethanol from mulberry tree sawdust by acid hydrolosis.

Making paper, one sheet at a time

Mulberry is also a widely used traditional folk remedy, used for "aphtha, armache, asthma, bronchitis, bugbite, cachexia, cold, constipation, cough, debility, diarrhea, dropsy, dyspepsia, edema, epilepsy, fever, headache, hyperglycemia, hypertension, inflammation, insomnia, melancholy, menorrhagia, snakebite, sore throat, stomatitis, tumors, vertigo, and wounds" (Duke and Wain, 1981).

Papering the bamboo frame of an Akari lamp

Mulberry twigs are used for making baskets, the sticks as beanpoles, and the wood for fuelwood, sporting goods (it's springy, like ash) and fine furniture. In Japan, the traditional "chashaku" green tea scoop used in semi-formal tea ceremonies is made of mulberry wood. If it's not mulberry then it's only an informal one. (Formal chashaku are supposed to be ivory.)


Isamu Noguchi with an Akari lamp

Japanese sculptor Isamu Noguchi used "shoji" paper made by hand from boiled mulberry tree bark for his famous **Akari lamps**, now regarded as pure modernist sculpture (there's a permanent exhibition of them in the Museum of Modern Art in New York). Noguchi was inspired by the traditional rice-paper lamps used by Japanese fishermen for night fishing.

Mulberry bark is also used for paper in Europe, and in Polynesia it is used to make a fabric called **Tapa cloth** -- an ancient craft that is now helping to save rainforests in the region.

New Guinea has the largest remaining tropical forest in the

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Asia/Pacific region, but it is under severe threat from industrial logging.

Maisin teenager in Papua New Guinea

The Maisin people of Papua New Guinea have rejected proposals from the big timber companies to sell their one million acres of ancestral rainforest. Instead, they have resolved to build their livelihoods from more sustainable practices, such as making and selling their traditional Tapa cloths, made from mulberry trees grown in their gardens. Green groups are helping the Maisin to find a worldwide market for their products.

Maisin Tapa cloth panels

Mulberries have been adapted to a very wide variety of local conditions. Japan has about 700 different types. The trees can grow from cool temperate to warm tropical regions, from dry to moist areas, from sea-level to as high as 3,300 metres.

Mulberry trees grow well in containers -- we planted a mulberry cutting in an old bathtub in our organic garden at our headquarters at the Beach House on Lantau Island. It was fruiting within weeks. Mulberries are attractive trees, and the fruit is delicious.

Silk, rice and fish

"Chinese Methods for Integrating Fish Culture with Crop and Livestock Farming" -- Integration of fish, livestock, and crop production in China has been refined for over 2,000 years. The system recycles resources, reduces organic pollution (livestock and poultry manure are good organic fertilizers for fish farming), and combines fish farming with mulberry cultivation for raising silkworms. The silkworm pupae are used as fish feed, and the worm faeces and wastewater from silk processing as pond fertilizers. Pond silt is used as fertilizer for fodder crops, which can in turn be used to feed livestock, poultry, and fish.
http://www.idrc.ca/nayudamma/fishcul_30e.html

"Rice-Fish Culture in China" edited by Kenneth T. MacKay, IDRC, 1995, 240 pp, ISBN 0-88936-776-0

Raising fish in rice paddies brings to farmers in Asia an important source of protein, as well as extra income. Biological and ecological aspects of rice-fish culture, and the economic and social dimensions. Full text online: http://www.idrc.ca/books/776.html

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Mulberry tree resources on the Web

Mulberry tree (Morus alba) seeds from **SBE Seed Co**. -- 50 seeds US$1.95
http://www.seedman.com/index/fruit.htm

All about mulberry trees, from the **California Rare Fruit Growers**, Inc.
http://www.crfg.org/pubs/ff/mulberry.html

Even more about mulberries from James A. Duke's **"Handbook of Energy Crops"** (1983, unpublished), at the Center for New Crops & Plant Products, Purdue University, Indiana: Uses, Folk Medicine, Chemistry, Description, Germplasm, Distribution, Ecology, Cultivation, Harvesting, Yields and Economics, Energy, Biotic Factors, References.
http://www.hort.purdue.edu/newcrop/duke_energy/Morus_alba.html

Yet more about mulberry trees, from **"A Modern Herbal"**, by Mrs. M. Grieve, originally published 1931. Interesting on history of mulberries, especially in Ancient Greece and Rome, and England: King James 1's famous edict promoting the widespread planting of mulberries to encourage English silk production -- only he got the wrong tree! Hence the lack of English silk. Shakespeare's famous mulberry tree, the sad fate thereof.
http://www.botanical.com/botanical/mgmh/m/mulcom62.html

Akari Light Sculptures at the Isamu Noguchi Garden Museum Store:
http://shop.store.yahoo.com/akaristore/akari.html

The **Isamu Noguchi Garden Museum**
http://www.noguchi.org/

"The Akari Light Sculpture of Isamu Noguchi" -- article by Bruce Altshuler
http://www.noguchi.org/baakari.html

Painting a Sustainable Future: Maisin Art and Rainforest Conservation in Papua New Guinea -- Image Gallery, Maisin Tapa, Background, at CorpWatch.
http://www.corpwatch.org/trac/gallery/maisin/index.html

Maisin Tapa cloth

"Jumping Lines: Maisin Art and Rainforest Conservation", Background Paper on the Maisin of Papua New Guinea, John Barker, University of British Columbia
http://www.bampfa.berkeley.edu/exhibits/jumpline/JBessay.html

Larry Rinder reports on a journey to the Maisin villages.
http://www.virtualschool.edu/mon/SocialConstruction/MaisinTapa/HotWiredJourneyTapa.html

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Kids' crazes

Keith writes:

Every year there was a kids' craze, at least one: the first one I can remember was the craze for playing cards. It was 1953 and I was seven, and all the kids got swept up by it.

We didn't actually play with the cards, well, not proper card games like poker. It didn't matter whether it was an ace or a six, spades, clubs or diamonds -- what was important were the pictures on the backs of the cards, and how many different kinds you had.

There were hundreds of them, more -- in no time a whole new currency system evolved: one of these rare ones with beautiful reproductions of Old Masters on the back were worth three of these, five of those; exchange rates, credit, debt. Poor kids and rich kids -- card millionaires. School breaks became frenzied playground trading sessions.

After a few weeks it ended. The cards vanished. Nobody cared about cards anymore. Nobody knew where they went, nobody knew where they'd come from. Peace for awhile. Then, marbles! -- cats-eyes, "goens" (big ones), marbles with an iridescent sheen, an amazing variety of marbles. These you didn't just trade, you had to win them, in complicated games involving flicking and rolling skills, games which somehow everyone knew already, nobody had to be taught.

Matchboxes, cigarette packets (empty), bottletops... What was strange about all this, though it didn't strike me as strange at the time, was the sheer profusion: where did it all come from? We had packets of cigarette brands that weren't even sold in the shops -- maybe in shops in other countries, but not in our shops; tops from bottles we'd never seen, matchboxes from all over the world. For awhile they'd be everywhere, then they'd vanish as mysteriously as they'd come and everyone forgot about them. The grownups (parents, teachers) never even knew about it in the first place.

Does this still happen, in these days of kids' fashions, kids' advertising, kids' media, and the global supermarket?

Some of the crazes were alive: at one stage everyone had white mice, cute little things with bright red eyes. They didn't mind travelling around in your pocket. We all had mice in our pockets. I can't remember the toilet arrangements, but I don't remember

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having smelly pockets either. I often had a chameleon hanging onto me somewhere as well, but I don't think that was a craze, I just had chameleons. Some kids had pimples, I had chameleons.

And silkworms. The silkworm craze came round a few times. In fact it never really vanished, like the cards and the other stuff, it just sort of ebbed and flowed. Silkworms were tidal. Sometimes there'd be yellow silk cocoons, sometimes bits of card covered with little eggs. Whichever, you'd put them in a shoe box with some holes in the lid. If cocoons, after awhile the moths would "hatch", softening the cocoons with spit and chewing their way out, lovely white moths covered in soft fur, wings too small and weak to fly. The males were thin, the females fat. After a while the females would lay eggs, then they'd all die.

It took a month or so for the eggs to hatch, producing a swarm of tiny black silkworms (caterpillars actually), and then would start the daily early-morning chore of raiding Old Man Russell's garden nearby to filch a supply of leaves from his precious mulberry tree.

The worms grew fast, and they grew fewer, until there were a few dozen large grey silkworms with huge appetites -- always a bit of a relief when they started spinning their webs in a corner of the shoebox and eventually vanished into a cocoon.

We knew you were supposed to boil the cocoons to kill the pupas inside before they turned into moths and chewed their way out again, ruining the cocoon, but we all thought that was cruel and I never heard of anyone doing it.

One cycle was usually enough -- you'd give the cocoons away, and give Old Man Russell's mulberry tree a break.

If it wasn't silkworms it was something else -- goldfish, tadpoles, tortoises, scorpions. Most of the kids generally had creatures of some kind.

Somehow I usually had birds, injured birds I'd nurse back to health, babies that fell out of nests, that had to be fed every hour.

None of this had anything to do with school. "Nature Study" was the name of a textbook, lessons twice a week, and written exams four times a year -- and none of that had anything to do with the

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creatures we kept. The two things were entirely separate, in fact and in our minds. Pocketsful of white mice, silkworms, pet scorpions, hungry nestlings -- such things just weren't in the school curriculum. And now they are. And that's progress.

A tailorbird nest -- feeding a nestling is full-time work.
-- Keith Addison

Care and cautions

Other creatures have just as much right to their lives as you have -- and maybe more: they're not responsible for as much pollution and waste as you are, you're more of a burden on the world than they are.

But you're more intelligent than a scorpion or a chameleon? You think so? This is intelligent:

"Man's work with Nature that further's Nature's aims is the work that rewards him the best." (I-Ching)

So if you want to be really selfish, use your intelligence to try figure out just what Nature's aims might be.

That might take you a long time. Scorpions and chameleons automatically further Nature's aims, they can't help it -- we can: we have the choice of being stupid about it. Just look around you!

Just playing: this reef egret walked the rope for fun -- it would have been much easier to fly.
-- Keith Addison

If you want to keep creatures, go ahead, you can learn a great deal from them. But treat them with respect -- they have lives of their own, they're not just toys to discard when you get bored with them. One thing they can teach you is the responsibility of caring for another life.

Lesson One

Find out just what's involved BEFORE getting a pet of any kind!

Most of the creatures I had as a kid weren't pets, they were wild, and we never kept them for long -- after a while we'd put them back where they came from. There's a great deal more to it if you live in a city, or if you want to keep something that comes from

another part of the world.

Want a pet scorpion? Try a giant black Emperor scorpion from West Africa -- ideal for beginners because of their "forgiving" nature and mild (ie non-fatal) sting.
Scorpions from Pets and Us (USA)
http://www.petsnus.com/scorpions.htm
Scorpion Caresheet from the Amateur Entomologists' Society
http://www.theaes.org/scorpion.htm

Emperor scorpion

Lots of information on scorpions at the **Tarantula's Burrow** at arachnophiliac.com -- also covers other kinds of adorable, cuddly wildlife like snakes and tarantulas.
http://www.arachnophiliac.com/burrow/home.htm

Naturalist Eugène Marais on scorpions -- or rather one scorpion:

"Let us turn to the study of the behaviour of another creature, which is zoologically classified near the insects, but which psychologically should be in the mammal class. I am referring to the South African scorpion.

"Among my tame scorpions there was a gigantic female which gained a good deal of fame. She was five and a half inches long. She first introduced herself to Mr Charlie Pienaar, by killing a full-fledged chicken in his presence. She tackled the chicken's leg, clung on, and gave one sting of her deadly lance, just above the joint. Within a few seconds the chicken was paralysed and was dead in ten minutes. Later on she became so tame and knew me so well that I could push a finger before her suddenly and allow her to grip me with her claws. She would bring her sting into contact with my skin, before recognizing me. Immediately she would relax and withdraw her dangerous weapon. I could handle her freely. She liked being scratched gently. Shortly after she came into my possession I noticed that an interesting event was shortly to take place. I watched her continually and gave her every care, for I wished to observe every stage of the process. I must admit that in those days I knew so little zoology that I expected to see her lay eggs. I was astounded therefore to see her give birth to sixteen living babies. Fully harnessed and spurred they made their entry by pairs, small white helpless babies -- but perfect little scorpions. There was no doubt at all that the delivery caused the mother much pain. I remember a woman asking me anxiously whether the young ones were born with pincers and stings, and then giving a prayer of thanks that human babies at least do not possess these.

"What seemed very strange, too, was that the scorpion mother loved her queer little youngsters. Very carefully she helped them on to her back, where they remained sitting in two rows with their heads and pincers directed outwards and their tails interlaced behind them. I knew her well enough to tell by her behaviour that she would not allow any handling of her babies, so I did not risk doing this until they were fully grown. The mother would tear their food into small pieces and feed them carefully, while above them she waved her sting defensively. A more loving mother you will find nowhere else in nature."
-- From "**The Soul of the White Ant**" by Eugène N. Marais, 1937, Chapter 10, Pain and Travail in Nature. Full text online. Contents:
http://journeytoforever.org/farm_library/Marais1/whiteantToC.html

Chameleons and more from Seaside Reptiles (USA)
http://veiledchameleon.com/index.htm

Diego Suarez chameleon

Good information from Michael Fry on **chameleons and keeping them** -- and cautions: not for everyone, hard to look after, they die easily!
http://www.skypoint.com/members/mikefry/chams.html

"Chameleons -- A Complete Pet Owner's Manual", R.D. Bartlett and Patricia P. Bartlett, 1995, Barrons Educational Series, Inc., ISBN 0812091574 $6.95
Chameleons are among the most sought-after members of the lizard family by terrarium owners, but they also require special care. This owner's manual tells chameleon fanciers everything they need to know. Filled with color photos and line drawings. From Barrons Educational:
http://store.yahoo.com/barronseduc/0812091574.html

The **Chameleon information Network** (CiN) is a worldwide organization of people with an interest in chameleons that "shares information about these unique creatures in order to maximize their chances of surviving in the future" and "supports conservation of the fragile natural environments of all chameleons around the world". Journal and other resources.
http://www.animalark.mn.org/cin/

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School gardens

Why school gardens?

School gardening projects fit easily into the curriculum and enhance studies in a wide range of subjects, but they also have a special value all their own. Some schools have always had gardens, but gardens for teaching have a more recent history.

Over the last 30 years many thousands of schools have incorporated gardening into the curriculum. With the growing experience of school gardening has come a great deal of evidence of the multiple benefits to be gained.

A small visitor to our garden -- he was fascinated with the pots of green pepper plants (Midori Hiraga)

Perhaps the main benefit is that schools with gardens are healthier schools producing healthier young people with healthier attitudes to life. The schools gardening movement is now spreading fast in all parts of the world.

"The wonderful thing about garden-based learning is that it's a hands-on, minds-on experience where my students and I learn together" (US teacher)

"Gardening should be as important a part of education as English, Maths and Science," says teacher and poet Peter Quince, writing in the January/February 2000 issue of **Resurgence**. See his reasoning in "Compost or Computers?", online: http://www.gn.apc.org/resurgence/issues/quince198.htm

Reading, Writing, and ... Gardening -- Environmental News Network, July 18, 2001: "We're trying to make the school garden an integral and exciting part of the school's classroom curriculum," says Jennifer Meux White, associate director for education of the University of California Botanical Garden, who specializes in science education. "The garden can be a rich learning experience." Thanks to a $500,000 grant, White and her team will take curricula they have developed around school gardens and tested at the botanical garden and schools throughout California and retool them for teachers across the US. http://enn.com/news/enn-stories/2001/07/07182001/gardening_44332.asp

The Journey to Forever garden

Our organic garden at the Beach House on Lantau Island in Hong Kong

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is a mix of the Square Foot Gardening and Container Gardening techniques, a simple and flexible organic food growing system for city-dwellers -- or for anyone.

This growing system is ideal for schools gardens and as a resource for school biology, ecology and environment projects.

Journey to Forever garden (Keith Addison)

In the US the Square Foot Foundation is working to get a garden in every school, with Internet resource links promoting inter-school collaboration and providing expert support.

Our system can even be adapted to conditions in Hong Kong schools which don't have school grounds.

The garden demonstrates that you can build a beautiful organic food garden on top of cement without any soil -- you can make your own high-quality soil by composting food scraps and other wastes. This waste recycling system is clean, hygienic and nuisance-free, and proven to be safe for children and in the home.

The organic waste-recycling system can be extended to homes and other institutions, and has the potential to make an impact on city waste-disposal and pollution problems.

There are many associated sub-projects. Together they offer a wide range of choices for schools.

Subject-areas:

- How to start: indoors or outdoors
- Waste-recycling -- turn kitchen scraps into new soil (kids just love this!) -- see **School composting**
- Recycling and improvising to minimize costs and waste
- What it takes to grow a meal
- Organic growing and health
- Basic ecology ("everything is connected to everything else")
- Sustainable agriculture
- Protecting genetic diversity, food security
- Networking and collaboration with other school gardeners along our route and in other lands
- Collaboration with city farms and community waste-recycling initiatives in other lands

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Caution!

Some schools gardening resources on the World Wide Web prescribe the use of harsh chemical fertilizers and toxic pesticides in classroom projects. We have a few words to say about this.

First, such projects teach children only half of nature's lesson, and it's an unbalanced half. The complete lesson from which children can benefit the most includes the full round of growth and decay, how the one depends on the other, and how, together, they compose a vivid example of the health, balance and sustainability of a natural system at work.

Second, today's children are aware of environmental issues -- they want a better and cleaner world, and they want to play a role in creating it. Teaching them the ways of the industrial style of agriculture which now stands guilty of so much of the pollution and environmental destruction children abhor is not what they deserve.

Make your school garden an **ORGANIC** garden!

See **School gardening resources**
School composting
Trees and forests -- resources for schools

See also:
Organic gardening
Composting
City farms
Small farms
Trees, soil and water
Seeds of the world

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School gardening resources

Square foot gardens for schools

A Square Yard in the School Yard -- a guide for teachers. Detailed guide for teachers to start Square Foot Gardens for their students, even with no gardening experience -- this Teacher's Kit tells you all!
http://www.farmerbrown.org/manual.html

School gardens

Schools Organic Network UK, recently launched by the HDRA -- the Organic Association, to introduce children to the pleasures of sowing, planting, growing, nurturing and eventually harvesting the food they eat, using organic methods. Practical help for schools, with everything related to the curriculum. "Today's children could be forgiven for thinking that bananas come from boxes, peas come frozen in packets, and tomatoes from tins. The real origin of these foods -- that they come from living plants which grow in the soil -- is not apparent." Tips & Advice, Learning Zone, Progress so far, Teaching Zone, Facts & Figures, Fun Zone, This half-term, Noticeboard, "Organic Gardening and its links to the National Curriculum" -- online booklet.
http://www.hdra.org.uk/schools_organic_network/index.htm

Sustainable Agriculture Curricula (K-12) from the Appropriate Technology Transfer for Rural Areas (ATTRA): Resource List, both audiovisuals and curricula/materials. "Sustainable agriculture curricula must be distinguished from agriculture appreciation curricula supporting conventional farming methods, on the one hand, and school gardening programs, on the other." This is a useful roundup of available resources for K-12 curricula.
http://www.attra.org/attra-rl/k12.html

"From the Ground Up -- Teachers' Guide Outline" from Green & Growing Environmental Education Project -- Is agriculture sustainable? Are there different approaches to farming? How do consumers affect trends in food production? How can society participate to assure that the food supply is sustainable? From the Ground Up began as a teachers' lesson guide on food, agriculture, and sustainable development. This on-line version is divided into five lessons: The History of Agriculture and a Description of Sustainable Development; Soil; Agriculture and Chemicals; The Real Cost of Food; Everything's Connected. Download the material, lessons, background essays, and worksheets for in-class use. Also an accompanying 1/2 hour video. French version available.
http://www.gatewest.net/~green/

Kids' Re-Generation Pages at the Rodale Institute website -- lessons, nature, history, everything about organic growing, with tours of the Rodale organic farm and organic garden: Hot Stuff From Down Under, The Smart Farm, Around the World in Your Garden, Science in the Fields, Bear's Path Stream Tour, Contests.
http://rodaleinstitute.org/kids/home.html
Kid's Re-generation Resource Network:
http://www.kidsregen.org/

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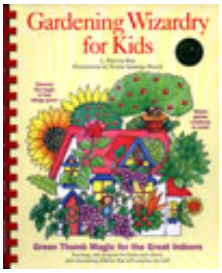
"Pachamama: Our Earth -- Our Future" by Young People of the World, 1999, Trafalgar Square, ISBN 0237521199

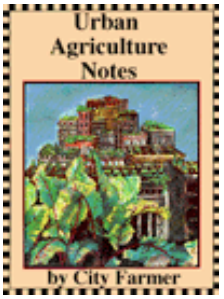
"Pachamama" is an Inca word meaning "mother earth" and implying harmony with nature -- something the hundreds of Young People of the World who authored this book strongly feel is missing in the way we live today. They warn young readers that if they're as reckless as their parents have been in caring for the environment "the good ship Planet Earth will crash sometime in the not too distant future". A good introduction by and for young people to the environmental challenges of the 21st century. Based on the United Nations Environmental Program's recent Global Environment Outlook 2000 report, it describes both the state of the world's environment and what's being done about it, especially by youth. Information, case studies, games and topics for classroom discussion of major environmental issues, complemented by a teacher's guide and suggestions to youth for taking action. Online, or buy the book:
http://www.unep.org/Geo2000/pacha/

Frogland -- this is a great website, full of fun and whackiness -- lots to learn here, without your even noticing that you're learning! "Serving you Froggy Silliness since August, 1995!" -- by Friend of Frogs Dorota of Frogland. Froggy Things to Do -- Stupid Frog Joke of the Day -- Frog of the Month -- WEIRD Frog Facts -- Save Our Frogs -- Frog FAQ -- Froggy Coloring Book -- International Frogs and much else, including Teachers Corner. This award-winning site has had nearly a million visitors.
http://allaboutfrogs.org/froglnd.shtml



"Gardening Wizardry for Kids" by L. Patricia Kite, Barrons, 1995, ISBN 0-8120-1317-4
"Green thumb magic for the great indoors" -- over 300 indoor projects, with colorful illustrations, uses cheap materials available in any household. With folklore and legends, seed catalog section, glossary, further reading list. From Barrons Educational:
http://www.barronseduc.com/0812013174.html
From Let's Get Growing!:
http://www.letsgetgrowing.com/bkwiz.html

"School Garden Guidelines -- How to Teach Children about Nutrition and the Environment", City Farmer, Canada's Office of Urban Agriculture.



From 1984 to 1986 hundreds of children and adults worked together to build a new playground and school garden at Lord Roberts Elementary School in Vancouver's densely populated West End. City Farmer took part in the project and published this 16-page booklet based on their experience. "Teachers have found that children involved in gardening projects are more interested in nutrition and food labels. The garden also provides a link with families who are often influenced by the children to grow food at home -- Nutritionally, a school garden project is a winner!" From City Farmer:
http://www.cityfarmer.org/
Also check out **City Farmer's web page on School Gardens** -- lots of information: Food Gardening in Schools, Nutrition and School Gardens, Education and School Gardens, Composting Activities For Children, The Case For More High School Gardens.
http://www.cityfarmer.org/schgard15.html#School

Green Teacher -- Education for Planet Earth
Based in Toronto, Green Teacher is a magazine by and for educators to enhance environmental and global education across the curriculum at all grade levels. Fifty pages of ideas and activities, four times a year: "We're not slick... just resource-full." Each issue contains: Perspective articles -- ideas for rethinking education in light of environmental and global problems; Practical articles -- reports of what successful teachers, parents, and schools are doing; Ready-to-use activities -- cross-curricular activities for various grade levels; Resource listings and reviews -- evaluations of dozens of new books, kits, games and other resources; School news, announcements, and more.
http://www.web.net/~greentea/

"The Kid's Garden Book - Pocket-Sized Farms" -- Produced by Life*Spin after three years of gardening with children in London, Ontario. Organized around the seasons, the book is designed for children to use as members of a school garden club or in their own backyards. Part of a package of materials to encourage schools to develop productive, inspiring gardens on currently barren school yards. Second part is Teacher's and Parent's Guide to Organic Gardening.
http://www.execulink.com/~life/programs/security/psf.html

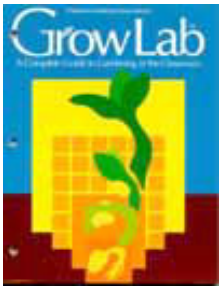
"Compost or Computers?" by Peter Quince, Resurgence January/February 2000 -- "Gardening should be as important a part of education as English, Maths and Science," says Quince, a poet and a teacher. "Gardening, in a youth culture, is for the middle-aged and the elderly. Gardening is for the retired and redundant. Gardening is a bolt-on leisure pursuit. Gardening is too slow in a world which insists on acceleration. Gardening isn't 'cool', has no street-cred, fails the macho test and is highly unlikely to lead into a lucrative career. Does this make sense? It does not. And I shall try to tell you why by way of illustrating an example of a primary school in which gardening is regarded, for a range of excellent reasons, as an integral and essential component of a sane curriculum. Not more important than English and Maths, but possibly as important in the sense of informing lifelong experience."
http://www.gn.apc.org/resurgence/issues/quince198.htm

KinderGARDEN by Aggie Horticulture, Texas, is a great resource for parents and teachers, many good resources and links for teaching children gardening. Fun Page for Kids, Introduction to School Gardens, Step-by-Step Guides, Indoor Growing Science Center, Ideas and Curricula, Nutritional Benefits of School Gardens, Resources and more. Good book list. Special Tips for Gardening with Kids: "Young kids have a very short attention span. Digging holes is one thing that seems to hold endless fascination... Instant gratification helps a lot. Plant radishes even if you don't like them -- they come up in three or four days... Growing their own will generally get kids to try eating things they otherwise wouldn't walk into the same room with... GETTING DIRTY IS AN INTEGRAL PART OF GROWING UP."
http://aggie-horticulture.tamu.edu/kindergarden/kinder.htm

KidsGardening! -- National Gardening Association: Garden Resources, Gardening for Families, Teacher's Garden and more.
http://www.kidsgardening.com/
Kids gardening books:
http://store.yahoo.com/nationalgardening/books.html

KidsGarden E-Mail News from the National Gardening Association -- Free monthly e-mail newsletter for educators, youth leaders, and gardening with kids enthusiasts. Timely articles and activities, FAQs, youth

gardening news, grant information, conferences, and more.
http://www.kidsgardening.com/newsletters/kidsgarden/
Subscribe: Kidsgardensub@kidsgardening.com
Unsubscribe: Kidsgardendel@kidsgardening.com



"Grow Lab: A complete guide to gardening in the classroom", US National Gardening Association, 1988, ISBN 0915873311
Guide and resource for gardening for children, giving detailed advice on setting up and maintaining an indoor classroom garden. Based on the National Gardening Association's 30 years of experience of gardening with children in schools, communities and youth groups. "We've watched children's curiosity blossom and confidence grow as they care for plants. We have listened to their questions as they puzzle out the great mysteries of growth. We have seen them renew their interest in regular school subjects that are enriched by the gardening experience." This book is the result of the NGA's search for an ideal school gardening program that teachers could easily use indoors, during any season, in any climate. Based on the proprietory GrowLab Indoor Garden system, but designed to be a comprehensive guide for every type of indoor classroom garden. From kindergarten to K-8. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/GrowLabCompleteGuideGardening.html

"Grow Lab: Activities for growing minds", National Gardening Association, 1990.
A kindergarten through eighth grade curriculum guide for indoor gardening, to help teachers "spark students' curiosity about plants and engage them in thinking and acting like scientists". The NGA worked with US teachers to develop and field-test this companion book to "Grow Lab: A complete guide to gardening in the classroom". Plants as teaching tools: "Once students experience the joy of using their senses and problem-solving skills to investigate their own questions, they realize that they can be scientists themselves. They find that science is not dull, scary, or 'just a bunch of facts', but fun and engaging." Indoor gardening resources provide opportunities for kids to engage in activities such as creating an indoor tropical rain forest, conduct classroom acid rain studies, or raise tree seedlings to complement studies on global warming. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/GrowLabActivitiesGrowingMinds.html

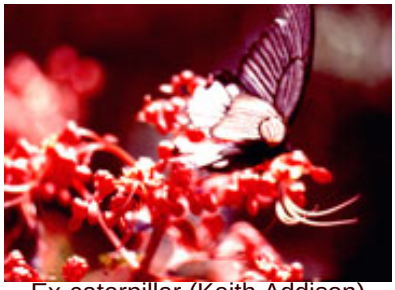
GrowLab indoor school garden

The National Gardening Association's Grow Lab books are part of the GrowLab K-8 Science Program, a complete system of indoor gardening for schools. The full Growing Ideas Teaching Tools Catalog is online at the NGA's Kids Gardening Store: GrowLab Indoor Gardens, GrowLab Videos, worm bins, GreenLab, growing curricula, kids' gardening books, and more.
http://store.yahoo.com/nationalgardening/growlab.html

Children's Butterfly Site, from the US Geological Survey's Midcontinent Ecological Science Center -- a coloring page of the life cycle of the Monarch, frequently asked questions about butterflies and moths, Butterfly and Moth Life Cycle, books and videos including Butterfly Gardens, Activities with Butterflies Teacher Resources, photo galleries, Ask a Question about Butterflies, links and resources and more, including translations into French, German, Spanish, Dutch, Italian.

http://www.mesc.nbs.gov/butterfly/Butterfly.html

Apprentice butterfly (Keith Addison)

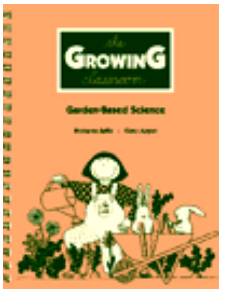

Ex-caterpillar (Keith Addison)

The Butterfly WebSite -- Photo gallery, Kids' Stuff, learn how to plant a butterfly garden, nature education, take a field trip, find a pen-pal, chat with other butterfly-lovers, articles, resources and more.
http://butterflywebsite.com/

Butterfly gardening and resources from **KidsGardening!**, National Gardening Association -- ButterflyLab, butterfly feeder, butterfly observation, live monarch butterfly collections, butterfly books:
http://store.yahoo.com/nationalgardening/butterflies.html

The award-winning **Life Lab Science program** is a core curriculum which integrates earth, life, and physical science concepts within the context of a Living Laboratory school garden. Inquiry-oriented lessons both outdoors and in the classroom encourage students to ask questions and explore solutions. Full curriculum offers a teacher's resource book, student lab book, and support materials such as the Life Lab Videodisc, Garden Log Calendar, and music cassette tapes. Science Discovery Kits with materials for science and garden explorations also available. Test projects online:
Soil for the Senses -- Grade 3
http://www.lifelab.org/soilsense.html
Soil Maker -- Grade 5
http://www.lifelab.org/soilmaker.html
Order Life Lab curricula online from Let's Get Growing:
http://letsgetgrowing.com/web_store.cgi?page=lifelab.html&cart_id=2777777_1578

"The Growing Classroom: Garden-Based Science" by Roberta Jaffe, Gary Appel, Kate Murray (Illustrator), 1982, revised 1990, Addison-Wesley, ISBN 020121539X



This is the Life Lab Science Program's original resource book, a teacher's manual with step-by-step instructions for setting up a school garden-based science program with supplemental curriculum, material guides, complete instructions. Growing, nutrients, garden ecology, climate, nutrition, and food choices. Planning the garden laboratory, implementing the curriculum, administrators, parents and the community. Four major sections: Breaking Ground, Science Units, Nutrition Unit, and a Resource Section, 160 garden-based activities using an indoor or outdoor garden laboratory, 35 different nutrition-related activities. For grades 2-6 (easily extended). Comes with some glowing recommendations.
Order online from Let's Get Growing:
http://letsgetgrowing.com/web_store.cgi?page=growing_class.html&cart_id=2777777_1578

"Getting Started: A Guide for Creating School Gardens as Outdoor Classrooms", Life Lab Science Program, 1997

Nearly 20 years of world-wide school garden experience with the Life Lab Science Program distilled into a concise 50-page guide that asks and answers most questions you need to consider for creating an outdoor classroom garden. Covers your garden's purpose; school staff, volunteers and students; connecting with the curriculum; site selection and design; theme gardens; fund-raising; public awareness and more. Order online from Let's Get Growing: http://letsgetgrowing.com/web_store.cgi?page=llgs.html&cart_id=2777777_1578

Great Plant Escape -- On-line interactive plant science curriculum for grades 4 and 5, from Chicago Urban Gardening, University of Illinois. Great educational site, fun and adventure while uncovering the world of plants. Parallel resources for teachers to guide the lessons as they unfold. Each of the lessons is interdisciplinary, designed to introduce students to plant science and increase their understanding of how foods grow. Includes maths, science, language arts, social studies, music and art. Students can work independently or in groups. "How Did Your Lettuce Grow? That's great. Your lettuce is healthy. Now we can go on and make a tossed salad." Clever, well-implemented. See also The Adventures of Squirmin' Herman the Worm, **Composting for schools**.
http://www.urbanext.uiuc.edu/gpe/index.html

TreEducation from **New Forests Project** -- dedicated to teaching more about trees, forests and their environment. Types of Forests -- What is mangrove? Ecology and Trees -- Why is groundwater important? Agroforestry -- What is Multi-Cropping? Nitrogen Fixation and Legumes -- What are Rhizobia? Solar Box Cookers -- What they are and how can I make my own? (See **Solar box cookers for schools**.) Free packages for teachers and students, information about the New Forests Project, a copy of Seedling News, tree fact sheets, tree seeds, planting instructions and other information about how to start your own chapter of the New Forests Seedling Club. Excellent resources, high-quality material.
http://www.newforestsproject.com/teacher.html

"The Children's Kitchen Garden" by Georgeanne & Ethel Brennan, 1997, Ten Speed, ISBN 0898158737

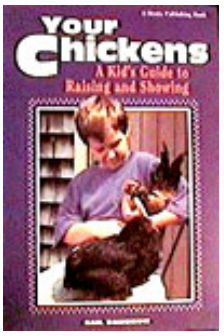
Inspired by the French tradition of teaching children to appreciate fresh and healthful foods, The Children's Kitchen Garden offers an approach to gardening, cooking, and learning that brings children and adults together. Basic gardening information to get started: choosing a site, preparing the soil, watering, and making compost from kitchen scraps; recipes children can help prepare; vegetables and herbs, with planting and cooking tips; projects for children (even five-year-olds) and adults to explore together. Learn how plants drink, watch sprouts grow, taste all kinds of foods from citrus to chocolate. Especially helpful for beginning gardeners. From ECHO's Global Bookstore:
http://echonet.org/shopsite_sc/store/html/ChildrensKitchenGarden.html

Kids Garden -- Suite101.com: good site with well-selected resources for kids' gardening: Articles, Links, Discussions. Compost/Vermiculture Web Sites, Fun/Educational Garden Web Sites, Garden Forums Web Sites, Garden Ideas Web

Sites, Kid/Family/Teacher Made Web Sites, Seed Starting Web Sites.
http://www.suite101.com/welcome.cfm/kids_gardening

"Gardening with Children Resource Guide", Ohio State University Master Gardener Program. A study of elementary school teachers in the US found that they seldom used school gardens -- though 84% felt that garden-related activities enhanced learning. One explanation was that teachers were unaware of educational resources to assist with garden learning. This manual is a resource guide for anyone interested in beginning or expanding children's gardening programs. The first section offers tips from two experts on designing gardens for kids and planning children's programs. The second section describes programs developed for children. The final section is a reference list of books, suppliers, web-sites, and organizations. 44-page Adobe Acrobat file.
http://www.hcs.ohio-state.edu/mg/Gardeningwithkids.html

"Your Chickens: A Kid's Guide To Raising And Showing"
by Gail Damerow, 1993, Storey Books, ISBN 0882668234
Raising healthy chickens for kids: what to feed them, where do you keep them, chickens as pets, and more. Clearly written and easy to understand general guide aimed at kids. Gail Damerow is the editor of Rural Heritage magazine and the author of eight books, including Chickens in Your Backyard, and Ducks and Geese in Your Backyard.
From Powell's books:
http://www.powells.com/cgi-bin/biblio?inkey=62-0882668234-0



Chickscope 1.5: Resources: From Egg To Chick -- Make an incubator out of two cardboard boxes or plywood -- this online schools biology project uses commercial heating elements or light bulbs in porcelain sockets. Expect about a 50% success rate with 3 dozen eggs (commercial incubators: about 80%).
http://chickscope.beckman.uiuc.edu/resources/egg_to_chick/incubator.html

Seeds of Change Garden -- A hands-on project from the Smithsonian Institution, emphasis on diversity and cultural exchange. Children plan, cultivate, and harvest the garden and interact with nature and each other, learning their similarities and differences through growing, cooking, and eating food, vital elements in all cultures. Teaches diversity and history by looking at the evolution of agriculture and cuisine throughout the world. Includes in-depth classroom or home activities, with support materials. Special pages for teachers and parents. Gardening is based on the seasons.
http://www.nmnh.si.edu/garden/
"A Garden Overview For Teachers and Parents -- A Practical Guide to Implementing an Educational Garden" by Swahti Best. Basic guidelines in this article:
http://www.nmnh.si.edu/garden/seasons/garden_overview.html

Michigan 4-H Children's Garden at Michigan State University -- This award-winning Children's Garden is being called "the most creative half-acre in America". On the campus of Michigan State University, the garden has 56 individual theme areas, all on-screen in 360-degree VR. Tree house area, butterfly area, rainbow area, maze area, pond area, chimes area, teddy bear garden, creation station, special child's garden, pizza garden, little prairie, enchanted garden, pharmacology garden, and more. Needs Flash and Quicktime VR. Plus more information about the garden and the web site.
http://4hgarden.msu.edu/index.html

See: **School composting**
Trees and forests -- resources for schools

See also:
Organic gardening
Composting
City farms
Small farms
Trees, soil and water
Seeds of the world

Community development | Rural development
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Beach House fish pond

-- "Aren't you breeding mosquitoes in that bathtub? Why're you growing water hyacinth? It's a terrible pest." -- Craig Leeson, journalist.

Garden ponds can be really beautiful, adding a sense of peace to a garden like nothing else can do. Others can provide you with a lot of food.

Water hyacinth flowers in the Beach House bathtub pond (Keith Addison)

The true contents of the Beach House Fish Pond:

- No fish
- Water hyacinth
- Duckweed
- No mosquitoes
- At least three frogs, which eat mosquitoes
- Lots of tadpoles, which eat mosquito larvae
- A small and elegant checkered keelback water snake (not poisonous), which eats tadpoles.

Frogs love our fish pond (Keith Addison)

The pond is an old bathtub propped on bricks. Sometimes we aerate it a bit with a small goldfish tank aerator, and we throw a handful of compost in it every month or so. All we put in it at first was a bathplug, water, and a couple of water hyacinths from a nearby paddyfield, which came with some duckweed. The tub quickly turned itself a balanced environment. The frogs moved in on their own. They make pleasant ratcheting noises when it rains. We've no idea where the watersnake came from.

More about ponds, including how to build one: **Garden pond**, **Aquaculture for small farmers**.

More about frogs: visit **Frogland** -- this is a great website, full of fun and whackiness, and frogs, lots of frogs.
http://allaboutfrogs.org/froglnd.shtml

Weedkiller Makes Male Frogs Into Females , Washington, Apr

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Japan

15, 2002 (Reuters) -- The most popular weedkiller in the United States can give male frogs female sex organs and other attributes, researchers said, in a study that could shed light on the global decline in amphibian populations. Very low levels of the herbicide atrazine can cause male frogs to grow female sex organs and curtail their croaks -- key to attracting mates in the frog world -- a team at the University of California Berkeley found.
http://www.planetark.org/dailynewsstory.cfm/newsid/15506/story.htm

Amphibians facing global decline, BBC News, 12 April, 2000 -- Evidence shows amphibians have been in decline globally for the last half-century, say researchers. They say their work provides conclusive proof of the decline of amphibians, which include frogs, toads, newts and salamanders. More than 200 scientists contributed data from 37 countries, covering 157 species from 21 families. The studies range from two to 31 years in duration. "The decline is yet another indicator of the long-term decline in biodiversity on this planet."
http://news.bbc.co.uk/hi/english/sci/tech/newsid_709000/709368.stm

Let's hear it from the frogs! -- WWF International, 21 February, 2002: Worldwide, disturbing reports of population declines, mass mortalities and species extinctions of amphibians have been accumulating for the last two decades, so much so that the World Conservation Union (IUCN) has established a Declining Amphibian Populations Task Force. On a global scale, South Africa has high amphibian diversity, but 23 of the nation's frog species (or 21%) are Red Data listed -- either threatened with extinction or are likely to become threatened in the near future.
http://panda.org/news/press/news.cfm?id=2739

What are weeds?

It's a bit difficult to say what "weeds" are, exactly. It's very subjective: weeds are plants growing where you don't want them to. And it turns out that you're the one who's out of place, not the weed.

There's hardly a weed that someone hates which someone else doesn't think is the most wonderfully useful plant.

Case study
Gardeners and farmers hate quack grass, or couch grass -- yet another of the many plants called "the world's worst weed". Here's what farmers think of quack grass:

"One of the worst pests with which the farmer has to contend, taking possession of cultivated ground and crowding out valuable crops."

And here's what the famed herbalist Nicholas Culpeper said about it:

"Although a gardener be of another opinion, yet a physician holds half an acre of them to be worth five acres of carrots twice told over."

More about quack grass: hate it and fight it, or eat it, make tea out of it, cure kidney troubles with it, grind it to flour and bake bread out of it, feed it to livestock, and more.

To understand the nature and role of "weeds" and "pests", see **Organic gardening -- Why organic?** and **Small farms -- Controlling weeds and pests**.

Pond weeds

As with other "weeds", so it is with these. The water hyacinth in our pond grows fast, helps to keep the water clean and fresh, has lovely flowers and produces lots of excess water hyacinth for the compost. Here are four current definitions of water hyacinth:

"the world's worst aquatic weed"
"the plant of the future"
"the Golden Weed"
"the answer to deforestation and pollution"

The tiny duckweed plants grow fast in the cooler months when the water hyacinth slows down, helping to suppress mosquitoes and also purifying the water. It also provides lots of rich food for the compost. Duckweed is also regarded as a serious pest -- "a severe nuisance when present in large masses" -- as well as "the most promising plant for the twenty-first century". "Duckweed has potential for use in controlled ecological life support systems for human exploration and development of space." (NASA)

Water hyacinth

Chinese villagers call it "pigweed" and always have some growing in a pond to feed to their pigs. It grows quickly and helps to keep the pondwater clean and fresh -- and they can use less crop land to grow food for the pigs.

Villagers in Bangladesh clear water hyacinth from the ponds and rivers and pile it on the banks to compost -- water hyacinth will compost all by itself. Then they plant vegetables in the compost piles.

The first person to recognize the full potential of water hyacinth (*Eichhornia crassipes*) was the brilliant agricultural scientist Sir Albert Howard, founder of the organic farming movement, while working in India in the 1920s.

He proposed using it for purifying sewage effluent. Later tests found that an acre of water hyacinth could remove 2.4 tons of ammonium sulphate (nitrogen fertilizer) in one hour, and phosphorus just as efficiently. (More recent work has found that it can also remove toxic heavy metal pollutants.)

Water hyacinth keeps the water clean (Keith Addison)

Howard found that water hyacinth is easily composted, and used as a fertilizer the compost had a vivid effect on rice yields.

"One of the greatest advances in food production in the world can be achieved by the conversion of water hyacinth first into humus and then into rice," he wrote in *An Agricultural Testament*. "No future rice famines in Bengal need be feared once full use is made of the vast local supplies of water hyacinth."

But it's still regarded as the worst aquatic weed in the world. It recently featured as PEST CABweb's "Pest of the Month". Attempts to control it with chemicals have failed (International Water Hyacinth Consortium, Washington, DC, March 1997) and caused further problems of chemical pollution.

Others take a different view. Water hyacinth is the potential solution to the man-caused soil erosion that makes the hyacinth spread so fast and do so much damage in the first place, according to ZERI (Zero Emissions Research Initiative).

And in the US the City of San Diego uses water hyacinth to clean the pollutants out of 1,200,000 gallons of waste water a day, including toxic heavy metals. Then they compost the water hyacinth and use it as a fertilizer -- what Sir Albert Howard proposed 70 years ago.

See **"The Water-Hyacinth: A Cinderella of the Plant World -- Its use in sewage effluents, as a trapper of salts and a water purifier"**, by G. C. Dymond, A.R.I.C.

Water hyacinth references

Duckweed

Duckweed (Lemna minor) is also seen as a pest weed that grows where people don't want it to, clogging waterways.

It's called duckweed because ducks eat it. So get more ducks! In

Duckweed in our pond -- another promising pest! (Keith Addison)

Vietnam duckweed is an essential part of an integrated rice-ducks-fish farming system: scavenging ducks are used to control insects and weeds in the rice fields and are fed duckweed growing in the fields, which is also used as a high-quality feed for fish.

Duckweed reproduces by budding, and it grows fast: "At the end of 4 months this would result in about 1 nonillion plants (1 followed by 30 zeros) occupying a total volume roughly equivalent to the planet earth!" says Wayne P. Armstrong at Palomar College.

"Duckweed produces more protein per square meter than soybeans," says Louis Landesman at the University of Southwestern Louisiana.

PRISM-USA calls it an "under-utilized family of plants both as animal feed and as a natural wastewater treatment technology".

The Worldwatch Institute says it's an efficient, low-cost water purifier. And NASA wants to use it in life support systems in space.

Duckweed references

Water hyacinth references

"Water hyacinth is the world's worst aquatic weed. It disrupts water transport and fishing. It disrupts hydro-electric power generation by blocking water intakes at dams. It seriously depletes aquatic biodiversity (including fish stocks) and affects water chemistry, and it harbours disease and snakes. Water hyacinth can be controlled using chemicals and by manual or mechanical removal. However, the only sustainable solution to water hyacinth is biological control." -- **PEST CABweb**, CAB International

Weed crisis: "Many African waterways are facing a crisis through the rapid spread of water hyacinth over the past two decades, and have concluded that the current strategies of chemical and mechanical control have failed in most instances. European Union countries have informed countries around Lake Victoria that they will not continue to purchase Nile perch, a major export earner for the region, if herbicides continue to be used to control water hyacinth. The African countries can no longer afford to use chemical or mechanical control as the basis for attempting to manage water hyacinth." -- **Proceedings of the International Water Hyacinth Consortium**, World Bank, Washington, DC, 18-19 March 1997

"The water hyacinth weed mainly thrives in water bodies surrounded by habitats experiencing excessive grazing and erosion of top soil, excessive use of agricultural fertilizers, and excessive deforestation, all caused by Man. The real long term solution to the water hyacinth weed problem, is to stop the soil erosion; to recover the mineral nutrients in the tissues of water hyacinth by promoting the use of the weed as an agro-fertilizer, as a livestock feed supplement, and as a source of other value-added products. On the utilization of water hyacinth as a resource, we must make peace with it, and stop declaring war against it." -- ZERI (Zero Emissions Research Initiative) info@zeri.org, based on "**A new hope for Africa**", Keto Mshigeni (editor) kmshigeni@unam.na, 1998, University of Namibia, ISBN 0947433899

See **"The Water-Hyacinth: A Cinderella of the Plant World -- Its use in sewage effluents, as a trapper of salts and a water purifier"**, by G. C. Dymond, A.R.I.C.

"Use Water Hyacinth!", by Keith Lindsey, Hans-martin Hirt, 1999 -- "The water hyacinth -- a beautiful flower, a noxious weed, or an absolutely free source of biomass? We, the authors of this book, believe that the water hyacinth can, and should, be used to advantage! Throughout the tropics, the words water hyacinth mean crisis. It has led to impure drinking water, prevented fishing, choked waterways, and even resulted in starvation. But maybe, in spite of everything, this horrendous weed presents a remarkable opportunity. This book is written in the belief that the water hyacinth, which grows at a phenomenal rate, can be used by people living throughout the tropics to increase their self-reliance, the quality of their diet and their general prosperity." The problems, the solutions, the uses of this amazing plant -- as fertilizer, as animal feed, for rope, crafts and furniture, as fuel, for paper and boards, other village-scale uses (eg soap-making), larger-scale and industrial utilization, simple equipment and techniques. From ECHO's Global Bookstore:
http://www.echotech.org/bookstore/

From the Water Garden Shop: Water Hyacinth: Excellent water purifier and algae preventative, $3.50
http://st7.yahoo.net/thewatergardenshop/waterhyacinth.html

"Water hyacinth is the plant of the future because of its amazing versatility. Frequently used to purify ponds, this South American native provides an ideal fish spawning ground among its long, purplish root masses. It can even be fed to cattle. Very prolific -- the Water Hyacinth does best when controlled in a warm water pool or tub." -- Sunset Koi Fish Farm in California

The City of San Diego uses water hyacinth to treat waste water at its San Pasqual Aquatic Treatment Facility, then composts the water hyacinth. "The San Pasqual Aquatic Treatment Facility is a constructed wetlands system using water hyacinth plants. Located in San Diego county, this facility treats 1,200,000 gallons daily of secondary sewage waste water. After treatment the water is recycled and used for sprinkler irrigation on three adjacent properties. The rapidly growing water hyacinth plants are ground to reduce volume and windrow composted to produce a clean, quality compost product useable as a mulch or soil admendment."

India's Ryan Foundation calls water hyacinth "a golden weed" -- it can be used to make high-quality paper, used for cattle feed, made into briquettes for villagers' cook stoves, and used to generate methane gas for cooking and heating: "not an environmental menace but an income generator. This weed must be commercialized and supplied to paper and board factories to save logging, deforestation and pollution."

Pigfeed recipe: "Boiled water hyacinth is used in Southeast Asia as a feed for pigs. The plants are chopped and sometimes mixed with other vegetable wastes, such as banana stems, and boiled slowly for a few hours until the ingredients turn into a paste, to which oil cake, rice bran and sometimes maize and salt are added. The cooked mixture is good for only three days, after which it turns sour. A common formula is 40 kg of water hyacinth, 15 kg of rice bran, 2.5 kg of fish meal and 5 kg of coconut meal." -- from "Water hyacinth, million dollar weed". http://www.fao.org/ag/AGA/AGAP/FRG/AFRIS/Data/381.HTM

Geese for Water Hyacinth Control by B.L. Damron and H.R. Wilson, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida -- The geese thrive, the water hyacinth doesn't. Simple. http://edis.ifas.ufl.edu/BODY_PS023

Toxic heavy metals removal: "[Water hyacinth] utilizes vast amounts of many nutrients which are poisonous to humans in these amounts. The water hyacinth has been shown to remove Nitrogen and Phosphates, as well as biochemical oxygen demands. In the process of studying water hyacinth's capabilities in sewage treatment it has been discovered that this plant removes trace toxic metals as well. It's ability to remove toxic heavy metals is what makes water hyacinth so appealing for treating the water at the UMTRA Site." http://www.geocities.com/CollegePark/Lab/9619/wahy1.html

World's Most Abundant Lake Threatened by Weeds

Environment News Service, November 8, 2000 -- BLANTYRE, Malawi: The water hyacinth is choking the life out of Lake Malawi, home to the largest number of fish species of any lake in the world. Malawi's Minister for Natural Resources and Environmental Affairs, Harry Thomson, calls it "a curse to the nation and the international community". The government tried spraying chemicals but that didn't work so they took to uprooting it and burning it. But Blantyre city assembly director of leisure, culture and environment Robert Kawiya said that in Sudan, water hyacinth from the Nile River is being used in biomass energy production for cooking, lighting and refrigeration. Water hyacinth waste has been used as organic fertilizer on farms, he said, while dried hyacinth can be used for growing mushrooms. In China, the water hyacinth is a prized raw material for livestock fodder. He said poverty stricken Malawians could learn from other countries who have realized the water hyacinth's potential.

Soobho Quality Handcrafted Products markets furniture made from water hyacinth straw -- and very eye-catching it is too. "Each item is individually handcrafted by skilled craftsmen, who have been using the same techniques of production for centuries."
http://soobho.com/ABOUT.HTM

Kinetic Studies of Biogas Evolved from Water Hyacinth, by F. Shoeb, H .J. Singh, Gorakhpur, India: AGROENVIRON 2000, 2nd International Symposium on New Technologies for Environmental Monitoring and Agro Applications, October 2000, Turkey -- Better than cow dung. 5,000-word paper.
http://ww2.green-trust.org:8383/2000/biofuel/KineticStudies.htm

Water hyacinths: turning a weed into a win-win situation -- In Thailand, this former waterway pest is fueling agriculture, exports - and more research. Note the word "former" -- the stuff is so useful they run out of it and have to bring it in from other areas. The perfect medium to cultivate valuable straw mushrooms -- for fiber board for construction -- an ideal component in fertilizer -- wickerwork for export made from the stems: water hyacinth is actually being cultivated to produce the long stems that are best for wickerwork -- methane gas production -- 'green fuel': water hyacinth compacted into cooking wood.
http://www.angkor.com/cityrain/Ron/ff/Water%20hyacinths%20turning%20a%20weed%20into%20a%20win-win%20situation.htm

"**Water hyacinth -- Use it!**": Water hyacinth can be very helpful in meeting some of the most urgent needs in tropical countries: in food production; as leaf protein concentrate, which is rich in protein and vitamin A; as a substrate for mushroom cultivation; by making soils more fertile which yield better crops; by purifying water, in which fish can then thrive; through the production of silage, for fattening animals;

through vermiculture, producing feed for poultry or fish; in regenerating degraded soils; as mulch; as compost; as fertiliser, produced by mixing with other organic materials, and phosphate rock.; in energy production, thereby combatting deforestation; as biogas, which can be used for cooking in kitchens for schools or restaurants; as briquettes, which can be used for cooking in place of wood; in providing employment and income, through the production and sale of a range of art papers and card, crafts and furniture, chemicals and liquid fuels. Utilisation makes economic and social sense. -- anamed, Germany.
http://anamed.y2z.de/English_Home_Page/Water_Hyacinth/body_water_hyacinth.html

Use Water Hyacinth! -- A Practical Handbook of Uses for Water Hyacinth from Across the World, by Keith Lindsey and Hans-Martin Hirt, January 2000
http://anamed.y2z.de/English_Home_Page/Water_Hyacinth/Use_Water_Hyacinth_/use_water_hyacinth_.html

Duckweed references

The **Duckweed Application Page** maintained by research biologist Louis Landesman at the University of Southwestern Louisiana: "Duckweed may be the most promising plant for the 21st century for the following reasons:
-- Duckweed produces more protein per square meter than soybeans
-- Duckweed is easier to harvest than algae or other aquatic plants
-- Duckweed can be used to feed fish, poultry and cattle
-- Duckweed can purify and concentrate nutrients from wastewater (sewage effluent)
-- Duckweed provides food for wildlife, especially waterfowl."
http://www.geocities.com/RainForest/Canopy/3631/

"Duckweek is low-cost water-purifier", says a Worldwatch Institute paper: "On a per-person basis, it takes two square meters of duckweed per person to do the purifying." Worldwatch Institute:
http://www.worldwatch.org/

PRISM-USA's **Duckweed Clearinghouse** "provides a single, comprehensive source of information on the duckweeds (Lemnaceae), especially practical knowledge about the cultivation of this under-utilized family of plants and their use both as animal feed and as a natural wastewater treatment technology." Annotated Abstracts, Full Text Publications, Project Reports, Other Sites.
http://www.prism-usa.org/

The Charms of Duckweed -- Practical Duckweed -- Large collection of well-organized annotated links to research papers and project reports on "the plant for the 21st century" in action. Lots of

good information on duckweed here.
http://www.mobot.org/jwcross/duckweed/

Harvesting fish from an integrated duckweed-fish farm in Bangladesh (PRISM)

"Its astronomical vegetative growth and the ability of some species to grow in stagnant, polluted water is why some duckweeds are well suited for water reclamation. Some species not only thrive on manure-rich water, but can be fed back to livestock, thus completing the recycling process. In addition, some species (such as Wolffia) are a potential source of food for humans because they contain about 40 percent protein (dry weight) and are equivalent to soybeans in their amino acid content (with high levels of all essential amino acids except methionine)." -- **Lemnaceae** (Duckweed Family), maintained by Wayne P. Armstrong at Palomar College.
http://daphne.palomar.edu/wayne/1wayindx.htm

"Trials on using duckweed cultivated as a partial or complete replacement of protein supplement for feeding crossbred and Muscovy ducks gave encouraging results. The practise of using scavenging ducks to control insects and weeds in the rice fields contributes to decreased investment and brings more benefits for the farmers. Duckweed grown in the integrated farming system is also a high-quality feed for fish." -- "**The Role of Scavenging Ducks, Duckweed and Fish in Integrated Farming Systems in Vietnam**" Bui Xuan Men, Faculty of Agriculture, Cantho University, Vietnam.
http://www.fao.org/ag/aga/agap/frg/conf96.htm/men.htm

Duckweed Research from NASA, on the NASA Technical Reports Server: "The effects of simulated weightlessness on the reproductive capacity of the great duckweed in the norm and under irradiation," Jan 01, 1978; "Natural systems for wastewater treatment and water reuse for space and earthly applications," Jan 01, 1987.

"**Duckweed -- a potential high-protein feed resource for domestic animals and fish**", by R.A. Leng, J.H. Stambolie and R. Bell, Centre for Duckweed Research & Development University of New England Armidale, NSW Australia, Livestock Research for Rural Development, Volume 7, Number 1, October 1995 -- "... duckweeds yield 10-30 ton DM/ha/year (dry matter per hectare per year) containing up to 43% crude protein, 5% lipids and a highly digestible dry matter. Duckweeds have been fed to animals and fish to complement diets, largely to provide a protein of high biological value. Fish production can be stimulated by feeding duckweed to the extent that yields can be increased from a few hundred kilograms per hectare/year to 10 tonnes/ha/year."

http://www.cipav.org.co/lrrd/lrrd7/1/3.htm

The Integrated Tilapia & Duckweed Farming System -- The fish and the waters of the tilapia growout ponds provide the nutrients upon which the duckweed will thrive. In turn, the duckweed removes unwanted nutrients and waste products from the system, converting the nutrients into plant biomass. This plant biomass, in turn, becomes a high protein food for the tilapias. While all this is going on, water within the integrated system is conserved and purified. The entire system is a natural and sustainable approach to aquaculture.
http://www.fishfarming.com/recirc.html

Duckweed Aquaculture -- A New Aquatic Farming System for Developing Countries, Paul Skillicorn, William Spira & William Journey, (1993) The World Bank -- "The PRISM Group initiated a pilot project in Bangladesh to develop farming systems for duckweed and to test its value as a fish feed. The results of the pilot operations were extremely promising; production of duckweed-fed carp far exceeded expectations, and dried duckweed meal provided an excellent substitute for soy and fish meals in poultry feeds. Duckweed could be grown using wastewater for nutrients, or alternatively using commercial fertilizers. Duckweed-fed fish production does not depend on mechanical aeration and appears to be significantly more productive and easier to manage than traditional pond fish culture processes." Full text online:
http://www.prismusa.homestead.com/files/Duckweed.htm
Color photos by Gregory D. Rose
http://www.fes.uwaterloo.ca/u/gdrose/image/prism.html

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Quack grass

Aliases: couch grass, dog grass, twitch grass, wheat grass, cough grass, cutch, quitch grass, quake grass, scutch grass, chandler's grass, durfa grass, durfee grass, Dutch grass, Fin's grass, Scotch quelch, devil's grass, witch grass

The accused

Agropyron repens (Beauv.), Triticum repens (Linn.)

Family: N.O. Graminaceae

Distribution: everywhere

Charges: Pernicious and troublesome behaviour, garden terrorism

Prosecution

"One of the worst pests with which the farmer has to contend, taking possession of cultivated ground and crowding out valuable crops." -- **"The Herb Hunters Guide"** by A.F. Sievers, 1930 http://www.hort.purdue.edu/newcrop/HerbHunters/quackgrass.html

"Quack grass is my totally unwanted weed. The roots are known to aid in kidney diseases, but other plants can do the same and besides, I have enough of this tenacious growth to cure the entire world population of kidney trouble. It is an ongoing struggle that will never end." -- Tina Finneyfrock, **"In Defense of Weeds"**, GardenGuides. She also gives a useful list of what some common weeds are telling you about soil conditions. http://www.gardenguides.com/articles/weeds.htm

Defence

"My favorite plant that most people consider a weed -- even a noxious weed -- is quackgrass. It is an excellent forage for cattle; it even received some attention from University of Minnesota plant breeders a couple of decades ago; it's drought-resistant, tillage-resistant, and appreciates manure. Interestingly, it is also recognized as allelopathic based on experiments in which root

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extracts from quackgrass were used to water other plants, which inhibited their growth. In the field, I suspect that any inhibition of other plants is due mainly to the phenomenal spreading root system of quackgrass." -- Jane Grimsbo Jewett, Minnesota Institute for Sustainable Agriculture, University of Minnesota

"Though commonly regarded in this country (UK) as a worthless and troublesome weed, its roots are, however, considered on the Continent to be wholesome food for cattle and horses. In Italy, especially, they are carefully gathered by the peasants and sold in the markets. The roots have a sweet taste, somewhat resembling liquorice, and Withering relates that, dried and ground into meal, bread has been made with them in time of scarcity." -- **"A Modern Herbal"** by Mrs. M. Grieve, 1931
http://www.botanical.com/botanical/mgmh/g/grasse34.html

"Although a gardener be of another opinion, yet a physician holds half an acre of them to be worth five acres of carrots twice told over." -- **"Culpeper -- The Complete Herbal"** by Nicholas Culpeper, 1653

"Although that Couch-grasse be an unwelcome guest to fields and gardens, yet his physicke virtues do recompense those hurts; for it openeth the stoppings of the liver and reins without any manifest heat." -- Gerard (quoted in Grieve)

Description

Pernicious weed. Couch grass has a creeping rhizome or underground stem just below the soil surface of the ground, with leaves and roots growing from nodes about an inch apart. Spreads rapidly, and quickly regrows from the smallest piece left in the ground -- very difficult to eradicate, and much more vigorous than most crops. It quickly forms a dense mat of roots that can strangle other plants. Much hated by gardeners and farmers.

Uses -- medicine

In Europe quack grass roots were used until quite recently to make a popular drink to purify the blood. It had many uses in traditional medicine in many cultures, especially for kidney ailments.

The roots are still used by traditional peasants in South China and Hong Kong to make a herbal tonic tea.

The CRC Ethnobotany Desk Reference by Tim Johnson lists couch

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A Lantau villager shows Christine Thery how to harvest quack grass to make traditional herbal tea.

grass as an anthelmintic, aperient, astringent, demulcent, diuretic, emmenagogue, emollient, sedative, sudorific, and a tonic, used for treating bladder ailments, cancer, congestion, cystitis, depurative, dropsy, gastrointestinal catarrh, gonorrhea, gout, jaundice, kidney irritation, liver ailments, nephritis, orthopedic ailments, painful urination, pyelitis, rheumatic problems, rheumatoid ailments, sclerosis (pylorus), stomach ailments, tumor, urinary ailments, and urinary tract irritation.

Other references cite its use as an antibiotic, antilithic, antimicrobial, antiphlogistic, bladder infection, blood purifier, used to treat Bright's disease, bronchitis, calculi, catarrh, constipation, cystitis, demulcent, depurative, discutient, diuretic, emollient, eyes, female disorders, fevers, gallstones, gout, gravel, jaundice, kidney, lower back pain, pectoral, prostate (enlarged), rheumatism, skin diseases, stones, sudorific, syphilis, tonic, urinary infections.

Other uses

The roots can be dried and ground to flour for making bread, or boiled to make a syrup which can be brewed to make beer. The roasted root is a coffee substitute. Young leaves and shoots are eaten raw in spring salads -- sweet but fibrous. Juice from the shoots is used to make a spring tonic. Seeds can be used as a cereal -- very fibrous. From **Plants for a Future** database -- which also says couch grass is used to stabilize dunes, can be made into an infusion which is a good liquid plant feed, and that a grey dye is obtained from the roots.
http://www.ibiblio.org/pfaf/cgi-bin/arr_html?Elytrigia+repens

Couch grass is the favourite herbal medicine of dogs and cats, which seek it out and eat large amounts of it. Also liked by cattle, sheep and horses.

Control

Frequent hoeing to keep new shoots down will eventually exhaust the plant and kill it. A good, thick, well-composted and

well-watered lawn will smother it, and so will a thick mulch, or a carpet, though it will take time. To control couch grass on a lawn, mow higher -- set the mower to more than 3".

Herbal recipes

From **"A Modern Herbal"**, 1931, by Mrs. M. Grieve
Medicinal Action and Uses -- Diuretic demulcent. Much used in cystitis and the treatment of catarrhal diseases of the bladder. It palliates irritation of the urinary passages and gives relief in cases of gravel. It is also recommended in gout and rheumatism.

It is supposed to owe its diuretic effect to its sugar, and is best given in the form of an infusion, made from 1 oz. to a pint of boiling water, which may be freely used taken in wineglassful doses. A decoction is also made by putting 2 to 4 oz. in a quart of water and reducing down to a pint by boiling. Of the liquid extract 1/2 to 2 teaspoonsful are given in water.

From **"Potter's Cyclopaedia of Botanical Drugs and Preparations"**, by R.C. Wren, F.L.S., Potter & Clarke, London, 2nd Edition.

Part used -- Rhizome (root).

Action -- Diuretic, demulcent, aperient. Used in urinary and bladder complaints, cystitis, nephritis, &c.

Also recommended in gout and rheumatism. The infusion, made from 1 ounce in a pint of boiling water, is taken in wineglassful doses several times daily for feverishness, &c.

Preparation -- Fluid extract: Dose, 1/2-2 drachms.

Distinctive character -- Rhizome slender, tubular, about 1/10-inch in diameter, stiff, shining pale yellow, smooth, with nodes at intervals of about an inch. It is met with in commerce, cut up into short lengths of 1/8 and 1/4 inch, and dried. Taste, slightly sweet. Odour, none.

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Eco-footprint

Are you too big for your boots? How heavily do you tread upon the world? Let's see how you measure up.

Your ecological footprint is the amount of land it takes to support your way of life, your lifestyle.

The worldwide average per capita footprint is 2.4 hectares, or 6 acres. If we leave only 12% of the biosphere for other species, there are less than 2 hectares available per person, or 5 acres each -- this means that we humans overshoot the mark by at least 20%.

That's a very important number -- it's the measure of just how "unsustainable" we are. This is why environmental issues are so important.

How many people have smaller eco-footprints than the world average? -- 73%, and very many of them don't have enough.

About 80% of humanity's total eco-footprint is taken up by 97.5% of the population -- they all have eco-footprints smaller than 12.7 hectares per person, or 31.4 acres each.

The other 20% of the global human eco-footprint is taken by only 2.5% of the world population. These are the few who have far too much. Without them, the overshoot would go back to zero -- we'd still be sustainable, though only just.

The ecological footprint of the average American is 12 hectares, 30 acres. The average Canadian needs one third less, and the average Italian 55% less.

So where do you stand?

This calculator will give you a rough estimate -- it assumes you're an average North American, but even if you're not it will give you an idea.
http://www.lead.org/leadnet/footprint/intro.htm

Use the Redefining Progress **Footprint Calculator** to assess the distribution of footprints and income worldwide. Requires a java enabled browser.
http://www.rprogress.org/programs/sustainability/ef/distribution.html

Redefining Progress has a lot of information and excellent resources on eco-footprints.
http://www.rprogress.org/programs/sustainability/ef/

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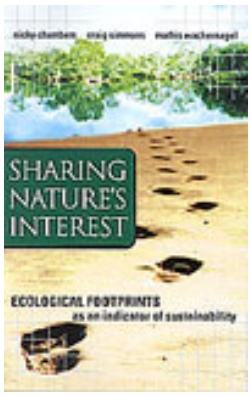
Ecological Footprint Lifestyle Calculator
http://www.bestfootforward.com/footprintlife.htm

Are you helping to save humanity or contributing to its downfall? You could be in for a shock. **New Scientist**.
http://www.newscientist.com/hottopics/environment/quiz1a.jsp

How many Earths would be needed if everyone on the planet enjoyed your standard of living? Find out how much land is needed to support your lifestyle -- your ecological footprint. **New Scientist: Global Environment Report**
http://www.newscientist.com/hottopics/environment/quiz2.jsp

Some comparisons of national energy consumption -- USA, EU, Germany, France, Japan, Australia, and India, Sudan, and Nepal. The average American uses twice as much energy as the average European or Japanese and 155 times as much as the average Nepalese. See **Energy Consumption**.



"Sharing Nature's Interest" by Nicky Chambers, Craig Simmons, Mathis Wackernagel, Earthscan, ISBN 1853837393
"An invaluable and accessible resource for any individual, business or communityou attempting to understand, quantify or explore human impact on the environment."
http://www.ecologicalfootprint.com/

"Turn the Tide" is a new online program to help ordinary people do something effective to protect the environment -- and keep track of how well they do so. The program, by the Center for a New American Dream, offers participants nine simple, ecologically smart ways to change their lives, from cutting car trips to canceling junk mail. The center describes the program as a "powerful tool" for demonstrating the impact of small changes in individual behaviour. Each member has a personal log, and the site calculates how many resources the member saves.
"Turning the Tide on the Environment", Washington Post, October 17, 2001
http://www.washingtonpost.com/wp-dyn/articles/A6317-2001Oct17.html
Turn the Tide -- Nine Actions for the Planet
http://www.newdream.org/turnthetide/

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2002/05/27 **IMF and World Bank: Out of Control**

THE International Monetary Fund and World Bank are institutions out of control. For evidence, consider the institutions' feeble and fatally flawed debt relief program. Under their Highly Indebted Poor Country (HIPC) initiative, the world's poorest countries can receive reduction of approximately one third of their current payments to overseas creditors -- if they endure six years of closely monitored, extremely intrusive "structural adjustment." ... HIPC is the institutions' most important fig-leaf, a program designed to obscure the view of the harm they are doing to poor countries.

2002/02/14 **Greenwash + 10**

The UN's "Global Compact" with global corporations associates with notorious violators of UN values -- Global Compact companies have already violated the Principles of the Compact, without censure -- or even acknowledgement -- from UN officials. The Global Compact represents a smuggling of a business agenda into the United Nations. It should not be considered a contribution to or framework for the Johannesburg Summit. Here's the evidence.

2001/11/15 **Technology and the poor**

The United Nations Development Programme's "Human Development Report 2001 -- Making new technologies work for human development" attempts to address a key question for the 21st century: will technology entrench millions in even greater poverty -- or can it be used to eradicate poverty and suffering? But it chooses the wrong challenge. The key issue is not "making new technologies work for human development". The challenge is enabling poor people to make technologies work for them.

2001/8/24 **Philip Morris Sees the Light**

After decades of denial about the hazards of tobacco, Philip Morris has been promoting the benefits to society of premature deaths from smoking, in a study that found the early deaths of smokers have "positive effects" for society that more than counteract the medical costs of treating smoking induced cancer and other diseases.
Updated resources.

2001/7/7 **The Enemies of Democracy**

Report of a chilling, documented history of ongoing corporate efforts to use propaganda and "public relations" to distort science, manipulate public opinion, discredit democracy, and consolidate political power in the hands of a wealthy few. Details, references, and lots of resources.

2001/5/26 **Murder that is a threat to survival**

There is a strong link between diminishing global biodiversity and the disappearance of languages. While new trees can be planted and habitats restored, it is much more difficult to restore languages once they have been murdered. It has taken centuries for people to learn about their environments and to name the complex ecological relationships that are decisive for maintenance of biodiversity. When indigenous peoples lose their languages, much of this knowledge also disappears. And languages are being murdered today faster than ever

before in human history.

2001/2/25 **Seed patents threaten world food resources**

Just as the Prince of Wales launched a millennium gene bank in Britain last November to conserve 10% of the plant kingdom, in Switzerland a threat appeared to the future availability of the seeds used to feed the world. Negotiations to keep their ownership in the public domain were only rescued at the 11th hour. These negotiations are a life insurance for humanity against rapid environmental, social and economic changes. Future food supplies will be under threat unless the talks succeed.
Updated resources.

2001/2/25 **The wreckers who trade in misery**

Dedicated and well-organised groups are ruthlessly chipping away at the remnants of the World Trade Organisation's (WTO) credibility. There is a real danger that they will cause the rules-based trading system to collapse, destroying efforts to reduce poverty and global inequality. The wreckers are not from the broadening anti-globalisation, anti-WTO protest movement. They are the governments of the world's richest countries, using their power to subordinate the WTO to their national interests and to the pursuit of corporate profit, regardless of the cost to poor countries, public health and the environment.
Updated resources.

2000/12/30 **BP -- Beyond Preposterous**

BP Amoco won a Corporate Watch "Greenwash Award" for its thoroughly misleading ad campaign "Beyond Petroleum". The slogan "Beyond Petroleum" is supposed to mean moving "beyond fossil fuels" to renewable fuels, but BP uses it to refer to its marketing push for natural gas -- a fossil fuel. BP spent more on its new eco-friendly logo in 1999 than on renewable energy. This was BP's second Greenwash award in 18 months. Read how BP boss Sir John Browne won a Greenpeace "Academy Award" for "Best Impression of an Environmentalist" for creating "an environmental fantasy of epic proportions". And behind the fantasy? Spin, lies, cheating, abuses, broken laws, pollution on a grand scale.
Updated resources.

2000/11/22 **Shell wins Greenwash Award**

Corporate Watch awarded its Greenwash Award to Shell for its ad claiming that Shell is at the forefront of reducing harmful greenhouse gases. Kenny Bruno, co-author of "Greenwash: The Reality Behind Corporate Environmentalism", takes a deeper look and finds that the company is full of hot air. Journey to Forever takes a further look, and finds that it's worse than that.
Updated resources.

2000/10/8 **Talking pure manure**

Agribusiness mouth Denis T. Avery keeps claiming that "people who eat organic and 'natural' foods are eight times as likely as the rest of the population to be attacked by a deadly new strain of E. coli bacteria (0157:H7)" -- despite solid proof that his "evidence" and "tests" are all falsified. In fact nearly all cases of E. coli 0157:H7 poisoning result from contaminated meat from industrial factory farms and meat processing plants, NOT organic farms. So why does he keep claiming it? Because the truth hurts.
Updated resources.

2000/5/19 **Hi-tech crops are bad for the brain**

"Miracle" crops, hailed as the answer to global famine, are contributing to widespread brain impairment in the developing world, a new report concludes. The high-yielding rice and wheat varieties of the "Green Revolution" are among a range of environmental factors undermining the intelligence of millions of people.

2000/5/3 **The WTO: "These guys just don't get it!"**

In response to the anti-World Trade Organization (WTO) protests, a Washington think-tank sponsored a day-long seminar entitled "After Seattle: Restoring Momentum in the WTO". "This was supposed to be a seminar on how to rebuild public confidence in the WTO, not transform the agency into the former Soviet KBG."

2000/4/5 **Countering myth with facts**

"Agriculture needs to counter false charges" and to "educate the general public and government officials" in order to "counter myth with facts", say two spokesmen of the American poultry industry. Myths to be countered with facts: animal welfare, worker safety, environmental contamination, antibiotic use.
Updated resources.

2000/4/1 **Rape of a rainforest**

Malaysian timber companies have become notorious for their systematic destruction of the world's remaining rainforests. Latest victim is Liberia, which has one of the largest surviving rainforest areas in West Africa -- report on an ecological and social crime.
Updated resources.

2000/3/17 **Do pesticides cause cancer?**

The answer, straight from the horse's mouth -- chemical corporation Monsanto's "Fact Sheet On Pesticide Use": "Number of active ingredients in pesticides found to cause cancer in animals or humans: 107." Read on!

2001/2/25 -- Update 2001/5/13

Seed patents threaten world food resources

By Patrick Mulvany and Don Redding

Patrick Mulvany is food security policy adviser and Don Redding head of public affairs for the Intermediate Technology Development Group.

Just as the Prince of Wales launched a millennium gene bank in Britain last November to conserve 10% of the plant kingdom, in Switzerland a threat appeared to the future availability of the seeds used to feed the world. Negotiations to keep their ownership in the public domain were only rescued at the 11th hour.

These negotiations are a life insurance for humanity against rapid environmental, social and economic changes. Future food supplies will be under threat unless the talks succeed.

At issue is the International Undertaking on Plant Genetic Resources for Food and Agriculture, or IU for short. It covers all the world's main food crops, and aims to ensure the conservation, sustainable use and "free flow" of these seeds so that they are

preserved and freely available for current and future generations.

The IU could keep access open to all crop, forage and agroforestry species used to maintain food security, including the 500,000 samples already in public-sector gene banks, as well as the hundreds of thousands of varieties in farmers' fields.

Smallholder farmers have developed and managed a wide number of seed varieties over centuries. Despite the expanding global trade in brand-name seeds and foodstuffs, up to 90% of the seeds used by these small farmers are saved on the farm andexchanged freely among their networks. These provide food for nearly two-thirds of the world's population.

But patenting of whole varieties and parts of the genome, and intellectual property rights regimes that support the biotechnology industries, are increasing the rate of appropriation of genetic resources from the south into private ownership in the north -- "biopiracy".

The IU would provide rules for a special category of genetic resources that are covered by the World Trade Organisation's trade-related aspects of intellectual property rights agreement. This agreement obliges countries to have measures for the intellectual property protection of plant varieties.

The IU's contentious central articles would ensure the free flow of these genetic resources, and reduce biopiracy. The IU would also ensure that farmers reap benefits from commercial use of genetic resources they have developed. It would be legally binding within the framework of the Convention on Biological Diversity (CBD).

When the nations that have signed the convention last met, in May last year, the Intermediate Technology Development Group -- a British-based charity that uses technology to find practical answers to poverty -- and partner NGOs brought smallholder farmers from Africa to the policy table: they demanded that the IU negotiations be concluded swiftly. The CBD has entrusted the United Nations Food and Agriculture Organisation (FAO) to host the negotiations.

A contact group of 41 countries is preparing the text for the FAO's conference of its 180 member states this year, and then to the CBD in 2002. Last August the group agreed on the text of the contentious articles, but at its meeting in Switzerland last November the United States, Canada, Australia and New Zealand reopened that text and blocked progress. These were almost the same countries that had tried to stall the biosafety protocol to the CBD and the climate change meeting at The Hague.

The contact group meets again next month. The European Union must seek an agreement that is strong on binding commitments. It should let its negotiators negotiate at the table without continually returning to their domestic departments and the Council of Ministers. Environment ministers should also line up behind the process. At stake is the world's access to a set of patent-free genetic resources on which we all

depend. Is that not worth an extra push?

-- The Guardian Weekly
18 January 2001

Up-to-date information on the negotiations can be found at the UK Agricultural Biodiversity Coalition website: http://www.ukabc.org/iu2.htm
International Undertaking on Plant Genetic Resources (IU) -- Call to Action •

Update: 10 February 2001
The Contact Group dissolved into various drafting groups. By the end of the day, the plenary session had still not reconvened. Serious misunderstandings remained about how to include the CGIAR centre genebanks in the IU. Simple wording to prevent IPRs [Intellectual Property Rights] on PGRFA [Plant Genetic Resources for Food and Agriculture] in the IU, "Recipients shall not claim any intellectual property or other rights that limit the facilitated access to the PGRFA in the Multilateral System;" was seemingly impossible to agree. All is not lost (other than precious negotiating time) and the CG will reconvene in April.

Maybe before then, political pressure from Ministers of Agriculture and Environment can be increased to ensure that negotiators have a clear mandate to secure an agreement in time for the Extraordinary Session of the Commission (CGRFA) in mid-2001.

Update: 3 May 2001
The Contact Group made progress and built up some momentum for agreement. A a result they agreed to send the outcome of their work to the FAO Commission on Genetic Resources for Food and Agriculture for adoption as a revised International Undertaking. This meeting will be in June at FAO Headquarters in Rome. But, while a lot of consensus was achieved - especially between Europe and most developing countries - there are still quite a number of issues outstanding, and a few powerful countries ready to torpedo the deal. -- UK Agricultural Biodiversity Coalition http://www.ukabc.org/iu4.htm#3

Update: 25 June 2001
World food 'under threat': Environmental groups said patenting by multinational corporations threatened food security and access by farmers to vital genetic resources. They said US efforts to block a new worldwide treaty on plant genetics would be every bit as damaging to life on Earth as Washington's refusal to implement the Kyoto Protocol on climate change. The criticisms were made in Rome where representatives from 160 governments are trying to get a binding global agreement that will govern the use of crop seed varieties and genetic resources. The number of crop varieties grown by farmers has plummeted by more than 75% over the past 100 years, as super strains have come to dominate the global market. This has increased the vulnerability of modern crops to major outbreaks of pests and diseases, which in turn has made the genetic diversity offered by older breeds highly valuable. -- BBC, 25 June, 2001

http://news.bbc.co.uk/hi/english/sci/tech/newsid_1407000/1407301.stm

Update: July 2001
The IU Hanging on its Last Brackets: A new global treaty to ensure food security through the conservation, exchange and sustainable use of plant genetic resources was roughly agreed to on 1 July 2001 at the UN Food and Agriculture Organisation (FAO) in Rome. But crucial issues remain unresolved. At stake is whether the world's agricultural biodiversity will provide private gains for a few or food security for all. -- GRAIN, July 2001
http://www.grain.org/publications/iu-july-2001.cfm

Update:
"Treaty to protect world's major food crops agreed -- but fight to protect their genes from patenting goes to new level" -- A vital new global treaty was agreed on 1 July to conserve and protect the genes in the world's major food crops. But rich Western corporations will continue to be able to patent the genes in these crops, thereby privatising them and denying access for others -- not least the farmers in developing countries who originated them. ITDG is calling on civil society organisations urgently to join its campaign to exempt these life-sustaining resources from patenting and privatisation. "Save world's crop genes from privatisation":
http://www.itdg.org/html/whats_new/plant_genetic_resources_a.htm

Update:
International Undertaking on Plant Genetic Resources (IU) -- Keeping free access to the world's plant genetic resources for food and agriculture - Some hope?
FAO Council and Conference 30 October - 13 November 2001 to finalise the IU -- but issues on IPRs, relationship with WTO and the List of Crops still to be agreed.
Civil Society Organisations React to Outcome of IU Negotiations
http://www.ukabc.org/iu2.htm

Update:
ITDG Briefing Paper "Who Will Own The Genes In Our Food?" (Acrobat file)
http://www.ukabc.org/WHO%20OWNS%20FOOD6%20June%2001.PDF

Update:
Trick or Treaty? -- How the IU became an IOU: Is The Law of the Seed a White Elephant Or the Mouse that could roar? -- Report from the ETC group -- the Action Group on Erosion, Technology and Concentration (formerly RAFI), December 6, 2001:
http://www.etcgroup.org/article.asp?newsid=276

Update:
A disappointing compromise -- Seedling, Volume 18, Issue 4, December 2001, GRAIN Publications
http://www.grain.org/publications/seed-01-12-1-en.cfm

Other resources

Institute of Science in Society, "Why Biotech Patents Are Patently Absurd - Scientific Briefing on TRIPs and Related Issues" by Dr. Mae-Wan Ho:
http://www.i-sis.org/trips2.shtml

"Why We Should Reject Biotech Patents from TRIPS" by Dr. Mae-Wan Ho and Dr. Terje Traavik:
http://www.i-sis.org/trips99.shtml

GRAIN, "Last chance for an open access regime?", Seedling, June 2000.
http://www.grain.org/publications/jun00/jun001.htm

RAFI, Rural Advancement Foundation International, "The Other BioSafety Protocol", GenoType, 20 February 2001. RAFI regularly follows the IU negotiations and produces briefing materials that can be found on their website.
http://www.rafi.org

Frequently Unasked Questions About the International Undertaking on Plant Genetic Resources -- RAFI, GenoType, April 19, 2001
http://www.rafi.org/article.asp?newsid=6

The **International Institute for Sustainable Development** reports in journalistic fashion from the scene of the IU negotiating sessions.
http://www.iisd.ca/biodiv/iu.html

See **Seeds of the world**.

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2001/2/25

The world must rein in the wreckers who trade in misery

By Kevin Watkins

Senior Policy Adviser for Oxfam UK

The wreckers have been at it again. In the year since the collapse of world trade talks in Seattle, dedicated and well-organised groups have

been ruthlessly chipping away at the remnants of the World Trade Organisation's (WTO) credibility. Without firm action there is a real danger that they will cause the rules-based trading system to collapse, destroying efforts to reduce poverty and global inequality.

The wreckers are not from the broadening anti-globalisation, anti-WTO protest movement. They are the governments of the world's richest countries, which continue to use their power to subordinate the WTO to their national interests and to the pursuit of corporate profit, regardless of the cost to poor countries, public health and the environment.

Media attention in Seattle, Prague and to some extent Nice focused on the street protests and the activities of a few balaclava-clad "globaphobes" with a disdain for McDonald's windows. But the real battle has been taking place off-camera, with developing countries challenging the northern governments' abuse of the system.

While poor countries have liberalised their markets, rich nations have remained protectionist, especially in areas such as textiles and agriculture. The authority of the WTO, which drives globalisation, has been extended into new areas, such as intellectual property rights. The negotiating process has continued to be profoundly undemocratic, with big countries stitching up deals in secret.

It was the failure of the United States and the European Union to address these concerns that produced the real debacle in Seattle in 1999.

Last month the European trade commissioner, Pascal Lamy, said he thought the time had come for the EU to consider reformulating its position on world trade negotiations if a new round of multilateral negotiations were to be launched. There was still no mention of the reforms that Britain and other countries had said were vital to make the WTO more democratic and accountable.

So the charade goes on. Take protectionism. Each year developing countries lose about $700bn as a result of trade barriers in rich countries: for every $1 provided by the rich world in aid and debt relief, poor countries lose $14 because of trade barriers. Reducing these barriers would create jobs and take millions of people out of poverty.

Unfortunately the post-Seattle record is abysmal. The industrialised countries promised to provide the 48 least developed countries - which account for 12% of the world's population but only 0.5% of trade - with improved market access. One year on, they have done nothing.

Poor countries exporting to the industrialised world face tariffs four times as high as those facing rich countries. Industrialised countries have promised to withdraw restrictions on imports of textiles, the third world's biggest manufactured export. But less than 10% of the restrictions have been lifted.

Nowhere are the double standards as deeply ingrained as in agriculture. US negotiators wax lyrical about the virtues of "level playing fields" in farm products. Yet the industrialised countries spend more than $240bn subsidising environmentally destructive intensive agriculture, and the "free-trading" US has increased farm subsidies over the past year.

Poor countries are losing export markets, and rural livelihoods are being destroyed on a huge scale because millions of poor farmers in Africa, Asia and Latin America cannot compete against subsidised imports. The resulting loss of food self-reliance is good news for the giant corporate grain exporters, who dictate US trade policy, but bad news for the fight against poverty.

India, Kenya and the Dominican Republic have been demanding a WTO food security clause that would them restrict imports in the interests of achieving food self-sufficiency. The US has blocked the proposal, claiming that it would distort markets. In reality the WTO is being used to ensure that US commercial interests supersede basic human rights.

The same principle applies to WTO rules on patents, which are the product of a lobbying campaign led by giant pharmaceutical and biotechnology companies. These rules have extended the duration and scope of patent protection, and backed corporate claims with the threat of WTO-sponsored trade sanctions.

One consequence is that countries with strong generic drugs industries will no longer be permitted to produce low-cost copies of patented drugs for low-income populations. These industries are able to produce drugs to treat HIV and Aids at less than one-20th of the market price of patented equivalents, providing a lifeline for millions of sufferers.

India and Egypt have asked for more time to find ways of adapting to the new regime. The American Pharmaceutical Manufacturers' Association has demanded US trade sanctions against both countries, and the US Trade Representatives Office has placed them on notice.

At a time when public health in poor countries is threatened by new diseases and drug-resistant variants of old killers such as diarrhoea, measles and pneumonia, WTO rules dictated by corporations and enforced by northern governments will deprive millions of poor people of access to vital drugs, causing premature death and suffering on an enormous scale.

We desperately need a rules-based system of global governance that places people before corporate profit, and shares the benefits of globalisation more equitably.

-- **Opinion**, The Guardian Weekly
18 January 2001

Resources

The WTO and Free Trade -- MUST-read 3-part article from the excellent Rachel's Environment & Health Weekly, #673-675
http://www.rachel.org/bulletin/bulletin.cfm?Issue_ID=1612&bulletin_ID=48
http://www.rachel.org/bulletin/bulletin.cfm?Issue_ID=1624&bulletin_ID=48
http://www.rachel.org/bulletin/bulletin.cfm?Issue_ID=1634&bulletin_ID=48

Making Sense Out of the WTO -- Rachel's Environment & Health Weekly, #679
http://www.rachel.org/bulletin/bulletin.cfm?Issue_ID=1657&bulletin_ID=48

Steps Toward A Corporate State -- Rachel's Environment & Health Weekly, #694
http://www.rachel.org/bulletin/bulletin.cfm?Issue_ID=1751&bulletin_ID=48

According to UNICEF, 1.5 million infants die each year chiefly because of false infant formula advertising. Guatemala was forced to choose between maintaining the UNICEF baby formula policy that has saved thousands of children's lives or facing an expensive defense in a WTO tribunal and then possible trade sanctions for not protecting the trademark rights of US baby food manufacturer Gerber, whose label violates the UNICEF code. In fact Guatemala had no choice.
http://www.rachel.org/bulletin/bulletin.cfm?Issue_ID=1646&bulletin_ID=48

A Citizen's Guide to the World Trade Organization: Everything You Need to Know to Fight for Fair Trade, August, 1999 (Acrobat file)
http://www.citizen.org/pctrade/gattwto/Reports%20&%20Publications/wto-book.pdf

"Whose Trade Organization? Corporate Globalization and the Erosion of Democracy" by Lori Wallach and Michelle Sforza, Public Citizen's Global Trade Watch, Preface by Ralph Nader: The 5-year track record of the World Trade Organization in language accessible to everyone. Documents the WTO's actual impact on democratic governance, wages, jobs, economic growth, food security, access to healthcare, food safety, labor rights and environmental protection.
http://www.citizen.org/pctrade/publications/wtobook.htm

Multilateral Agreement on Investment (MAI) -- **The MAI Shell Game**
http://www.citizen.org/pctrade/Shell_Game/Cover.htm

MAI Provisions and Proposals: An Analysis of the April 1998 Text
http://www.citizen.org/pctrade/otherissues/MAI/What%20is/ANALYSIS.htm

Global Fair Trade Principles -- A coalition of 44 groups has proposed five principles to guide US trade policy.
http://lists.essential.org/pipermail/tw-list/2001-August/000077.html

Global Issues That Affect Everyone -- excellent resources on Trade Related Issues: The Causes of Poverty, The Effects of Debt, Free Trade and Globalization, Corporations, Fair Trade, and much more.
http://www.globalissues.org/

WTO Watch -- The Trade Observatory on WTO, Globalization, Trade and Sustainable Development
http://www.wtowatch.org/

Global Trade Watch (GTW) was created in 1993 to promote government and corporate accountability in an area on which few public interest groups were focused: the international commercial agreements shaping the current version of globalization. GTW is a division of Public Citizen, the national consumer group founded in 1972 by Ralph Nader.
http://www.tradewatch.org/

Developing Countries in Despair over WTO preparations for Doha
http://www.focusweb.org/publications/2001/developing_countries_in_despair.html

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UPDATED -- 2001/1/12

2000/12/30

BP -- Beyond Preposterous

In November the giant oil corporation **Shell** won the **Corporate Watch** "Greenwash Award" for claiming to be at the forefront of reducing harmful greenhouse gases, while in reality it is one of the planet's worst greenhouse gas culprits. (See FYI 2000/11/22.)

Greenwashing: Corporate public relations campaigns that promote an eco-friendly image, when a company's practices are precisely the opposite.

In December it was the turn of another giant oil corporation -- **BP Amoco** won the Greenwash Award for its thoroughly misleading ad campaign "Beyond Petroleum". "Beyond Belief," commented the Earth Day Network's Grist Magazine. "Beyond Preposterous," said Corporate Watch. "Beyond Pretentious."

See "Greenwash Award: BP: Beyond Petroleum or Beyond Preposterous?"
http://www.corpwatch.org/greenwash/bp2.html

Even the slogan "Beyond Petroleum" has been purloined from the environmental movement, and its meaning cynically twisted -- it's supposed to mean moving "beyond fossil fuels" to renewable fuels, but BP uses it to refer to its marketing push for natural gas -- a fossil fuel.

BP has no intention of moving beyond fossil fuels. Corporate Watch says BP will spend US$5 billion over five years for oil exploration in Alaska alone. BP spent more on their new eco-friendly logo last year than on renewable energy.

This is BP's second Greenwash award in 18 months. The first was for the oil giant's bizarre "Plug in the Sun" Program, launched on March 13, 1999, when BP boss Sir John Browne announced that it would install solar panels in 200 gas stations around the world.

"We can fill you up by sunshine," claimed BP -- but it was gasoline that went into the tank, not sunshine. BP spends just 0.01% of its portfolio on solar energy as it explores for more oil and sells more gasoline. BP's oil and gas account for about 2% of all global greenhouse gas emissions.

See Summer Greenwash Award: BP Amoco's "Plug in the Sun" Program:
http://www.corpwatch.org/trac/greenwash/bp.html

A month after his solar announcement, on Earth Day, April 22, 1999, John Browne won two awards. Almost as bizarre as the solar campaign itself, Browne was presented with an environmental leadership award at an Earth Day ceremony at the United Nations. Greenpeace countered by giving Browne an "Academy Award" for "Best Impression of an Environmentalist". See BP Head Wins Earth Day "Oscar":
http://www.greenpeaceusa.org/media/press_releases/99_4_22.htm

Greenpeace said behind Browne's portrayal of BP Amoco as a leader in solar energy lay a company with far greater investment in dirty fossil fuels that are causing global warming.

"As director of BP Amoco, John Browne has created an environmental fantasy of epic proportions," said Gary Cook of the Greenpeace Climate Campaign.

He said 99.95% of BP Amoco's recent investments were in fossil fuel concerns, while solar investments had actually declined. "If we are to avert catastrophic global warming we cannot afford to burn 75% of the fossil fuels we've already discovered," Cook said. "Yet John Browne wants to spend $4 billion to open up new oil fields in the Arctic."

Words and deeds

In a speech at Stanford University in May 1997, Browne said: "There is a discernible human influence on the climate and a link between the concentration of carbon dioxide and the increase in temperature."

Browne also said BP needs to take into account the views of the society in which it operates.

But Kenneth E. Blower, BP's director of health, safety and environment, said the company's decision to address climate change was a business one: "We want to be early into this [issue] -- this will be valuable to stockholders in the long term."

And Britain's Prime Minister Tony Blair, talking of "environmentally aware oil companies" (sic) during a speech on the environment, said: "As BP's John Browne has said, the enlightened company increasingly recognises that there are good commercial reasons for being ahead of the pack when it comes to issues to do with the environment."

Perhaps the exact motivation wouldn't matter if the company was actually doing something about it. But is it? Something more than the 0.01% it spends on solar energy, that is?

In 1998 Browne publicly endorsed the precautionary principle. This is important -- without it, greenhouse gas offenders like BP could simply say, "There's no conclusive proof that it's affecting the climate."

The precautionary principle shifts the burden of proof. As the Rio Declaration of the 1992 United Nations Conference on Environment and Development (the Earth Summit) puts it: "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

In 1999 BP duly quit its membership of the Global Climate Coalition, a Washington-based lobbying group that opposes the Kyoto climate treaty and claims that there is insufficient scientific evidence to confirm that greenhouse gases are causing global warming.

BP's Environmental Policy Adviser Charles Thomas said: "The emphasis for us is very much on emissions reduction. That is what Kyoto is all about."

And indeed, BP has made a public commitment to reducing its own emissions by 10% by the year 2010.

But this is more greenwash. BP's direct emissions are peanuts -- BP's main role in causing global warming is not from company emissions, but from the oil and gas it produces, which generate more greenhouse gas emissions than those of Canada, Britain, or Central America.

Meanwhile Friends of the Earth and other environment groups are considering suing fossil fuel companies and industrialized nations that are blocking implementation of the Kyoto treaty.

Tony Juniper, policy and campaigns director at Friends of the Earth UK, raised the subject of a global warming damage lawsuit at a recent conference hosted by BP.

The BP attorneys "said that climate change hasn't been proven", Juniper told reporters.

For all the hot air at the top, that's the bottom line. And Browne's plans to spend $4 billion to open up new oil fields in the Arctic prove it.

Renewable energy

The real level of BP's interest in renewable energy was demonstrated recently when the company took legal action in the European Court of Justice against France's tax exemptions for its burgeoning biofuels industry producing bioethanol and biodiesel, both of which come from plant sources, are carbon neutral, and much cleaner-burning than their fossil-fuel equivalents.

BP claimed the tax breaks risked distorting its own markets for fossil fuel-derived synthetic ethanol -- mainly methyl tertiary butyl ether (MTBE), which is used to increase the octane content of lead-free gasoline. MTBE is filthy stuff (see below). The French bioethanol-derived equivalent, ETBE, does exactly the same job, but it's clean.

Nonetheless, the court ruled that the French tax exemption for ETBE was unacceptable -- a victory for BP, a blow for everybody else. But the court accepted the exemption for biodiesel. France has applied to continue the ETBE exemption under a different provision, but will need the agreement of all the EU member states to do so.

MTBE

MTBE is a public health and environmental nightmare, now widely banned in the US, with 90 environment and health groups pushing for a total ban -- which was passed by the Senate but didn't get any further. Intense lobbying by oil companies was cited as a

reason.

MTBE Fact Sheet:
http://earthisland.org/bw/MTBEfacts.shtml

"**Is There Gas in Your Glass?**" -- the true scope of the MTBE problem:
http://www.earthisland.org/eijournal/fall98/eia_fall98bluewater.html

"**MTBE Leaks Are A Ticking Bomb: Gas additive taints water nationwide**" -- San Francisco Chronicle:
http://www.sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/1998/12/14/MN18353.DTL

GAO warns MTBE fuel leaks in water more widespread -- Washington, May 22, 2002: Contamination of water supplies by MTBE is more widespread in local communities than previously thought, because the gasoline fuel additive has leaked from pipelines across the United States, the General Accounting Office warned Congress.
http://www.planetark.org/dailynewsstory.cfm/newsid/16070/story.htm

The MTBE Cover-Up -- "the oil industry knew about MTBE threats to drinking water before the controversial gasoline additive was introduced in California":
http://www.carbohydrateeconomy.org/ceic/news/news.cfm?news_id=61

Big Oil's MTBE Cover-Up -- "By 1991 the industry was using more than 100,000 barrels of MTBE per day in reformulated gasoline. Yet secret oil company studies, conducted at least as early as 1980, showed the industry knew that MTBE contaminated ground water virtually everywhere it was used."
http://www.alternet.org/story.html?StoryID=14274

MTBE: What The Oil Companies Knew And When They Knew It -- Election-Year Deal in Congress Would Shield Industry From Lawsuits for Water Contamination -- Internal Industry Documents Are Rewriting The MTBE Pollution Story -- EWG's report "**MTBE With Knowledge**"
http://www.ewg.org/reports/withknowledge/

Never mind pretty new logos and stolen green slogans and "enlightened" speeches --- this is the true nature of oil corporations like BP.

The Arctic

BP is one of the companies champing at the bit to drill in the pristine Arctic National Wildlife Refuge. They claim they could do so in an environmentally benign fashion.

On September 23, 1999, BP pleaded guilty to a federal felony connected to illegal dumping of hazardous waste at their Endicott Oil Field near Prudhoe Bay, Alaska. BP

agreed to pay $22 million in criminal and civil penalties. A BP contractor had dumped thousands of gallons of toxic waste at the oil field between 1993 and 1995, one of the worst environmental crimes in the history of North Slope oil drilling.

Alaska has meanwhile imposed new restrictions on BP's drilling operations in the state's Northstar field because the company failed a number of spill-response tests.

Greenpeace and other groups, including indigenous Eskimoes, have been fighting BP's Northstar oil drilling operation, and virtually the entire environment movement opposes its plan to drill in the Arctic National Wildlife Refuge.

"Allowing BP Amoco to drill in the Arctic Refuge is like putting a drunk driver behind the wheel of a school bus," said Athan Manuel, director of the US Public Interest Research Group's Arctic Wilderness Campaign. "There is nothing green about BP Amoco. They drill for oil in sensitive ecosystems, contribute to global warming, and pollute the environment every day."

He's wrong, there is something green about BP. They keep winning Greenwash Awards.

Human rights

A broad coalition of Tibet, human rights and environmental groups is campaigning against BP over its investment in a Chinese oil firm building a pipeline on traditional Tibetan land.

The coalition of 54 groups, including Friends of the Earth, the Sierra Club, movie star Richard Gere and Adam Yauch of the rock band Beastie Boys, are demanding that BP use its influence to halt construction of the pipeline through Qinghai province.

The coalition says the project will lure more Chinese settlers, upset the delicate ecosystem and deplete natural resources with little benefit for locals. They said BP's claim it had no interests in Tibet was "disingenuous and evasive" and it had taken no concrete action in six months of talks with Tibet support groups.

The Dalai Lama has said investments in oil and gas projects in Tibet are harmful to Tibetans and called on BP Amoco to withdraw investments from PetroChina.

-- Reuters, Beijing, December 10, 2000
http://www.planetark.org/dailynewsstory.cfm?newsid=9275

"Lawbreaker"

Latest award: On December 27, 2000, in an article entitled "Enemies of the Future", the **Multinational Monitor** announced its list of the Ten Worst Corporations of 2000. It awarded third place to "BP/Amoco: Lawbreaker".

"The oil giant which likes to portray itself as environmentally responsible paid major fines and entered settlements in 2000 for illegal disposal of hazardous waste, alleged Clean Air Act violations, and underpaying royalties for oil produced on federal and Native American lands."

Full story:
http://www.essential.org/monitor/mm2000/00december/enemies.html

BP accused of spiking gas prices

Update -- 2001/1/12
BP Amoco bumped up West Coast oil prices by exporting Alaskan crude to Asia for less than it could have sold it to US refiners, according to experts' reports and court records obtained by The Oregonian newspaper.

The documents, which the newspaper filed suit to obtain, were part of a Federal Trade Commission analysis of BP's proposed $26.8 billion buyout last year of Atlantic Richfield Co.

In a 1995 e-mail exchange described by the newspaper, BP managers discussed "shorting the West Coast market" to achieve "West Coast price uplift scenarios" by shipping Alaska crude to the Far East to "leverage up" prices on the West Coast.

An expert hired by the FTC said BP had tightened oil supplies to raise the price of millions of barrels of crude oil shipped to refineries in California and Washington state since 1996. He estimated this drove up West Coast pump prices by 1 to 3 cents a gallon. He said the e-mail was one of many "smoking gun" documents he reviewed.

BP officials dispute the FTC experts' conclusions. Oil companies have blamed the Northwest's higher prices on OPEC cutbacks, refinery fires, taxes and pipeline disruptions.

Oregon's senators have asked two Senate committees to investigate the allegations.

Wyden, Smith ask Senate inquiry of BP Amoco gas-price actions
http://www.oregonlive.com/news/index.ssf?/news/oregonian/01/01/lc_62oil12.frame

BP pays $650 million in clean-air lawsuit

Update -- 2001/1/19
BP Amoco will spend an estimated $650 million to settle a federal clean-air lawsuit by cutting ozone-producing pollutants at its eight oil refineries across the US. As part of a consent decree approved in a US District Court, BP will install pollution-control equipment and pay $10 million to settle Clean Air Act violations. The lawsuit, filed by

the Environmental Protection Agency, alleged BP violated several clean air laws at its refineries.
-- BP corporation spends $650 million for cleaner air
http://ens.lycos.com/ens/jan2001/2001L-01-19-09.html

Holier than thou

Update -- 2001/1/19
BP Amoco said government fuel taxation policies are driven more by financial income than green ideals. "We have observed that governments are apparently more driven by revenue than environmental objectives when setting the level of fuel duties," the company said in a written report to the UK Parliament's Enviromental Audit Select Committee.

:-)

BP says govts put fuel revenues over environment
http://www.planetark.org/dailynewsstory.cfm?newsid=9569

"Row as BP blocks debate on environment" -- AFP, March 2, 2001
London -- Oil giant BP is struggling to shake off accusations that it is stifling discussion of its environmental and human rights policies, in a furious row that goes to the heart of the climate change debate. BP admitted that it had sought to prevent lobby groups who have the support of its shareholders from debating resolutions on the environment and on human rights at a BP annual general meeting next month. The lobby groups, who include Greenpeace and the Free Tibet Campaign, accused BP of a "disregard and disrespect for its shareholders," while an independent corporate governance advisory body, PIRC, said the move "smacks of corporate arrogance."
http://www.iol.co.za/html/frame_news.php?click_id=143&art_id=qw983523902940B216

BP employees question safety of drilling technology -- The technology that US President Bush says will allow drilling in the Arctic National Wildlife Refuge to be environmentally sensitive has "the potential for a natural catastrophe," the Wall Street Journal reported (April 13, 2001). Most experts agree that the technology for ANWR drilling would replicate operations under way in Alaska's Prudhoe Bay oilfields. But Alaska inspectors discovered last month that almost a third of the safety shutoff valves tested at one Prudhoe Bay drilling platform failed to close. And secondary valves often fail as well, BP Amoco technicians say. The BP employees say the design problems put worker safety and the environment at risk. BP Amoco executives defended its Prudhoe operations, saying they were safe.

MI6 'firm' spied on green groups: A private intelligence firm with close links to MI6 [British Military Intelligence] spied on environmental campaign groups to collect information for oil companies, including Shell and BP. -- The Sunday Times, London,

June 17 2001
http://www.sunday-times.co.uk/news/pages/sti/2001/06/17/stinwenws01016.html

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2000/11/22

Shell wins Greenwash Award

Corporate Watch has awarded the latest Greenwash Award to Shell for its ad claiming that Shell is at the forefront of reducing harmful greenhouse gases. Kenny Bruno, co-author of "Greenwash: The Reality Behind Corporate Environmentalism", takes a deeper look and finds that the company is full of hot air.

Greenwashing: Corporate public relations campaigns that promote an eco-friendly image, when a company's practices are precisely the opposite.

Clouding the Issue

By Kenny Bruno
November 15, 2000

As the Sixth UN conference on Climate Change in the Hague got underway, one of the planet's largest corporate climate culprits dared to raise its profile by taking out an advertisement in the Financial Times about the global warming issue. Shell, the world's third largest oil company, was continuing its clever but misleading series "Profits or Principles" with the ad pictured right.

The ad is pretty, of course, and it sounds reasonable, caring and honest. But Shell has a history of "greenwash" -- green-themed advertising and public relations aimed at presenting an environmentally responsible image. So let's take a deeper look at the "Clouding the Air" ad.

Shell asks: "Is the burning of fossil fuels and increased concentration of carbon dioxide in the air a serious threat or just a lot of hot air?" It sounds like a tough question, but it's not. There is overwhelming scientific opinion that both fossil fuel use and CO2 emissions are a serious threat.

The main reason for the "hot air" theory is a major effort by the oil

Shell's Greenwash

Cloud the Issue or Clear the Air? The issue of global warming has given rise to a heated debate. Is the burning of fossil fuels and increased concentration of carbon dioxide in the air a serious threat or just a lot of hot air? Shell believes that

industry, among others, to discredit climate change science in the eyes of policy makers and the public. Shell has been among the companies questioning the science since 1988, although in recent years it has finally admitted that enough is known to call for a precautionary approach.

Shell says that "last year, we renewed our commitment not only to meet the agreed Kyoto targets to reduce greenhouse gas emissions, but to exceed them." This is a fine step, but not nearly as significant as it might seem.

Like the other fossil fuel giants, Shell's impact on the climate stems not primarily from its use of oil and gas, but from its production. Oil produced by Shell alone accounts for more carbon dioxide than most countries in the world. Steps to address this much larger role would be significant, but instead Shell continues a worldwide effort to locate and produce more oil and gas that the world cannot afford to burn if it is to avoid catastrophic climate change.

Shell says, "We're working to increase the provision of cleaner burning natural gas..." In theory, natural gas leads to somewhat lower carbon emissions than burning of oil for the same amount of energy. But if you count gas leaks, known as fugitive emissions, the difference between gas and oil for the climate is slim to none, and impacts on the local environment and communities are similar to those of oil.

Natural gas is at best an incremental improvement over oil, and at worst a distraction from the real challenge of moving our economies beyond fossil fuels.

Meanwhile, other ads in the "Profits or Principles" series tout Shell's commitment to renewable energy sources. They feature Shell photos of lush green forests accompanied by earnest discussion of this purported commitment. But, according to Greenpeace, Shell spends a miniscule 0.6% of its annual investments on renewables. In true greenwash fashion, Shell's actions do not match its words.

action needs to be taken now, both by companies and their customers. So last year, we renewed our commitment not only to meet the agreed Kyoto targets to reduce greenhouse gas emissions, but to exceed them. We're working to increase the provision of cleaner burning natural gas and encouraging the use of lower-carbon fuels for homes and transport. It's all part of our commitment to sustainable development, balancing economic progress with environmental care and social responsibility. Solutions to the future won't come easily, particularly in today's business climate, but you can't find them if you don't keep looking.
-- Financial Times 11/14/2000

Says Shell, "It's all part of our commitment to sustainable development." Their ad writer should read an essay in Shell's own glossy "Profits and Principles" booklet. Buried in the expensive and lovely pages of that publication is this nugget of truth: "…a sustainable oil company is a contradiction in terms."

"Cloud the Issue or Clear the Air?" Long-time Kyoto Protocol watchers are aware of the powerful role the oil industry has played in slowing and weakening the agreements on climate change. Self-proclaimed corporate environmentalist leaders like Shell and

BP take credit for voluntary initiatives that do not harm their bottom line, while allowing others to do the dirty work of making sure international agreements do nothing to curtail their activities.

The pictures and copy in Shell's ads are clear. But in the atmosphere of the climate negotiations, they have clouded the issue once again.

http://www.corpwatch.org/greenwash/shell.html

The Shell advertising campaign is a response to years of criticism of the company's poor environmental and human-rights record. Most of the criticism centers on Shell's collusion with the Nigerian government to suppress the Ogoni people on whose land in the Niger delta Shell drills its wells. The oppression continues to this day, and peaked in 1995 with the execution of Ogoni writer and activist leader Ken Saro-Wiwa and five others.

"This is it -- they are going to arrest us all and execute us. All for Shell." -- Ken Saro-Wiwa, two weeks before he was arrested, May, 1994.

Between 1976 and 1991, 2,976 oil spills blackened the Niger delta, an average of four a week.

Shell games -- Project Underground: Exposing corporate human rights & environmental abuses; supporting communities threatened by the mining & oil industries.
http://www.moles.org/ProjectUnderground/motherlode/shell/shellgame.html

Welcome to the World of Greenwash, where transnational corporations (TNCs) are preserving and expanding their markets by posing as friends of the environment and enemies of poverty -- Kenny Bruno on the Orwellian realm of sham environmentalism.
http://www.corpwatch.org/trac/greenwash/world.html

Update -- 2001/1/10

Shell awarded Environment Gold Medal

Royal Dutch/Shell has been awarded the World Environment Center's 17th Annual Gold Medal for International Corporate Environmental Achievement.

Commenting on the award, Shell group managing director Sir Mark Moody-Stuart said: "My colleagues and I are totally committed to a business strategy that generates profits while contributing to the well-being of the planet and its people."

The WEC Gold Medal is awarded by an "independent Jury of distinguished international environmental experts to a corporation that demonstrates preeminent industry leadership and contributes to worldwide environmental quality". BP is a previous winner.

The jury cited Shell for its commitment to sustainable development, "as a guiding principle for its worldwide operations and as a cornerstone of the company's management values".

Bit of a Freudian slip in the press release though: "Also factoring into the Jury's decision was Shell's leadership role in global climate change [right!] which it considers one of the most controversial and pressing environmental issues of our time."

WEC says it is an independent, not-for-profit and non-advocacy organization. It was founded in 1974 with a grant from the United Nations Environment Programme (UNEP).
http://ens.lycos.com/e-wire/Jan01/10Jan0101.html

Updates

Shell oil spill hits Nigerian Delta state: Royal Dutch/Shell's Nigerian producing unit said it had shut in 46,000 barrels per day of output after an oil spill in Nigeria's southern Delta State. The trunkline was promptly closed to prevent crude oil from polluting the environment, it said. The cause of the spill had not yet been established. Shell denied a Nigerian newspaper report that farmlands had been affected by the spill. -- Reuters, January 10, 2001
http://www.planetark.org/dailynewsstory.cfm?newsid=9491

MI6 'firm' spied on green groups: A private intelligence firm with close links to MI6 [British Military Intelligence] spied on environmental campaign groups to collect information for oil companies, including Shell and BP. -- The Sunday Times, London, June 17 2001
http://www.sunday-times.co.uk/news/pages/sti/2001/06/17/stinwenws01016.html

Back to **Index**

Handmade Projects Journey to Forever Hong Kong to Cape Town Overland

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Journey to Forever
Hong Kong to Cape Town Overland

ジャーニー・トゥ・フォーエバー

What's new

Rural development

Appropriate technology

Project vehicles

Internet interaction

http://journeytoforever.org/jp/

FOODFIRST

Rural development | Appropriate technology | Project vehicles

http://journeytoforever.org/jp/

AN INTERACTIVE ADVENTURE –
- the first-ever overland expedition from East Asia to Southern Africa
- the first to use the Internet to link schools and communities all along the route
- the first to offer schoolchildren everywhere an active role in confronting the environmental issues threatening the future of our planet

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Handmade Projects
Chiba Pref.
Japan

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ENERGêA

enlazando.com/energia

Este sitio est‡ dedicado a la energ’a, en sus distintas formas, en especial, a aquellas que representan una rotura en las cadenas que intentan atarnos al petr—leo, un recurso contaminante y que cada vez resulta m‡s caro.

- ENERGêA

Comisi—n Nacional de la Energ’a:

- Escasez de representantes de las organizaciones defensoras de Medio Ambiente (uno de 36 miembros).

- Inexistencia del fomento de las energ’as renovables.

Cogeneracion

- ELECCIîN DE COMERCIALIZADOR DE ENERGêA

Puede informarse sobre la libre selecci—n de comercializador de energ’a elŽctrica o gas en el telŽfono **901 10 2003** de la Comisi—n Nacional de la Energ’a y el Ministerio de Econom’a (TelŽfono de la Elegibilidad EnergŽtica).

TambiŽn en esta web del Ministerio de Econom’a.

- PETROLEO Y ENERGêA NUCLEAR .

Grupo sobre la energ’a nuclear-f—sil .

Informaci—n sobre el precio de carburantes petrol’feros en las Gasolineras

Plataforma de Consumidores de Carburantes

Contaminaci—n AtmosfŽrica.

Lucha contra el efecto **invernadero**. El ejemplo italiano.

La necesidad de que s—lo se permitan los **combustibles con ultra bajo contenido en azufre**, para proteger el medio ambiente y luchar contra la lluvia ‡cida.

- MERCADO DE HIDROCARBUROS.

La dificil competencia en el Mercado de los Hidrocarburos. Condicionamiento a la aparici—n de nuevos agentes en el Mercado.

Defensa de la Competencia : sanci—n a CEPSA.

- TRANSPORTES ALTERNATIVOS

El **VELOTAXI** (tambiŽn llamado Velocab, Biketaxi, Taxi-Tricycle, Taxi-Trike, Bicycle Rickshaw o Pedicab) es un taxi para hasta dos pasajeros movido mediante pedales, capaz de sortear los atascas y no utiliza ninguna energ’a contaminante.

www.workbike.org/research/pedalline.

M‡s p‡ginas y direcciones sobre velotaxi

- ENERGêAS RENOVABLES.

Ha quedado m‡s que demostrada la conciencia ecol—gica de la gente con el des-***prestige*** del petr—leo y las recientes mareas negras que ha tenido lugar en Galicia, donde multitudes de voluntarios han luchado contra los efectos da–inos del petr—leo.

Asociaci—n Espa–ola de Biodiesel y de la Energ’as Renovables (A.E.B.E.R) : Estatutos, Afiliaci—n...

Fomento de las energ’as renovables : esta p‡gina tiene como finalidad el facilitar a los poderes pœblicos un marco general para la elaboraci—n de normas destinadas al fomento de las

energ’as renovables

VEGETALES

Aceite Vegetal (Vegoleos).

Uso general del Biodiesel en Gales. El petr—leo de capa ca’da.

Biodiesel. En esta p‡gina le ense–amos a **fabricar caseramente su propio biodiesel a partir del aceite vegetal o grasas animales y a utilizarlo en su actual veh’culo de gasoil** (es decir, no es neceario adquirir un coche nuevo, sino que cualquier coche de gasoil puede utilizarlo). TambiŽn podr‡ participar en una lista de correo sobre Biodiesel.

Balance energŽtico del Biodiesel

La primera empresa que comenz— a fabricar Biodiesel en Espa–a : Grupo Vila / Stocks del VallŽs representante para Espa–a de Biodiesel Intl . En la actualidad son ya varios los operadores de biodiesel en nuestro pa’s.

Biodiesel para mezclar con el gasoil petrol’fero para lograr carburantes con poco azœfre, de acuerdo con las directivas europeas de obligado cumplimiento.

Bioalcohol . Pilas de bioalcohol.

Motor de aire

Energ’a solar / **C—mo preparar su hogar o empresa para utilizar la energ’a solar (preinstalaci—n muy econ—mica).**

Energ’a eolica para hogares

Banca Ztica para la financiaci—n de proyectos de energ’as renovables.

- **HIDROGENO**

Bruselas crea un Grupo de Alto Nivel sobre Hidr—geno y Pilas de Combustible. El inconveniente : no hay actualmente tantos vehiculos de hidr—geno, como vehiculos diesel.

Bush quiere que EE.UU. lidere la tecnolog’a de hidr—geno

Es importante el obtener un **certificado** sobre :

- el origen del hidr—geno que vamos a utilizar, en la gasolinera. El m‡s respetuoso con el medio ambiente es el obtenido a partir electricidad -electrolisis- de la biomasa (resulta aconsejable rechazar el hidrogeno obtenido de materias que procedan de la biomasa, como es el gas natural petrol’fero) y mediante energ’as renovables no contaminantes (solar fotovoltaica, e—lica, etc...)
- c—mo va a utilizar el veh’culo el hidr—geno, antes de comprar el coche. Se ha comprar uncoche de pila de energ’a **PEM (Proton Exchange Membrane)**. No comprar nunca un vehiculo que utilice el hidr—geno para ser quemado.

M‡s sobre hidr—geno.

- ENERGêA EL*f*CTRICA.

ELECTRICIDAD VERDE : sepa el origen de la electricidad que consume . En todo caso, se ha de tener en cuenta que no toda la energ’a verde es **ecol—gica**. La energ’a ecol—gica es aquella que se obtiene de fuentes no contaminantes (**sol, viento**). De otro lado, la energ’a hidraœlica no se puede considerar ecol—gica ya que el agua que se utiliza en su producci—n es un bien agotable (todo lo contrario que el viento y el sol).

Real Decreto 2818/1998, de 23 diciembre, sobre producci—n de energ’a elŽctrica por instalaciones abastecidas por recursos o fuentes de energ’a renovables, residuos y cogeneraci—n.

ÀQuŽ es la cogeneraci—n?.

Veh’culos elŽctricos . Ginger el veh’culo de transporte personal.

Telecomunicaciones utilizando la red elŽctrica.

- ELEGIR COCHE

En esta p‡gina tiene algunas orientaciones sobres aspectos a tener en cuetna a la hora de elegir su coche.

- INFRAESTRUCTURAS ENERGƒTICAS Y CONSTRUCCIONES SOSTENIBLES

DOMƒSTICAS : infraestructuras comunes de transporte de energ’a en edificios; canalizaciones de gas frente a bombonas de butano; preinstalaciones de energ’as renovables.

El **fomento** de las energ’as renovables en la **Ley de la Propiedad Horizontal**.

Consejo de Industrias de Construcciones Sostenibles

- OTROS ENLACES DE INTERƒS.

Agencia Reginal de Gesti—n de la Energ’a de Murcia (ARGEM) Telf : 968 36 84 15

Ingenieros Sin Fronteras.

E.T.S.I. Agr—nomos PolitŽnica de Madrid, Departamento de Producci—n Vegetal.

- ENLACES HACIA OTROS TEMAS

Terremotos

Z

(Z = **Z**ero Meridian **— UTC)**.

(reloj **est‡tico**, para actualizarlo vuelva a cargar la p‡gina)

Ver y a–adir relojes UTC en la web.

P‡gina de la Energia, en especial de las renovables (biodiesel/hidrogeno) y de la elŽctrica .

Est‡ndar internacional para la hora en Internet

KEITH ADDISON

JOURNALIST

Nationality	British/South African
Age	58
Email	keith@journeytoforever.org

PROFESSIONAL DETAILS

Work description	Journalist, writer, editor
Experience	37 years (total 20 years freelance)
Work areas	General writing, news/business features, special projects
Subject areas	General, Third World development, environment, IT, science, arts
Published	The Independent, The Observer, The Guardian, New Scientist, many other newspapers, magazines, journals
Books	'On This Day', best-selling world history book for Octopus Illustrated (planning/coordination, main author); 'Planet Earth', Marshall Editions (contributing author); 'Hong Kong, Singapore and Bangkok', American Express travel guide (coordinator, co-author); others

HISTORY

From May 1997	Hong Kong: Freelance writer, editor, consultant; started work on Journey to Forever (Hong Kong to Cape Town Overland)
1996-Apr. 97	Hong Kong: Senior copy editor, Hongkong Standard (freelance contract)

1994-96	Hong Kong: Freelance writer, columnist, editor, consultant -- General freelance reporting -- NHK (Japan), monthly East Asia media briefings, Jan. 1995-Jan. 96 -- Columnist (full page) for Hongkong Life, weekly tabloid magazine, Oct. 1994-Jan. 1996 -- Information technology and telecommunications (Telecommunications Research Project at the Centre for Asian Studies, University of Hong Kong; the Telecoms Infotech Forum; Law-On-Line, Faculty of Law, HKU)
1993-94	Hong Kong: Senior copy editor, Hongkong Standard
Jan. 1993	Stockholm: Arranging and taking part in an international seminar on 'Electronic Information and Journalism' at Stockholm University School of Journalism and Communications Studies
1991-92	London: Proprietor of South Pole Publishing Services, an environmental publishing agency -- produced a daily electronic newsletter for world NGOs at the UN Climate Talks Ministerial Conference in Nairobi Sept. 1991; wrote and produced Annual General Report for Britain's National Organic Gardening Association, 1992; others
1989-91	London: Features sub-editor, The Independent
1987-89	Amsterdam: Publications Editor and Science Editor at the Royal Tropical Institute (KIT), Holland's main Third World development agency, which runs about 80 projects in developing countries and covers all aspects of rural development and primary health care. It also has a major tropical diseases laboratory, a large ethnological museum, and an international research library. I worked with all departments, editing and producing technical and non-technical books, manuals and journals on a wide variety of subjects for the Institute and for other institutes (WHO, CTA, etc).
1986-87	England: Freelance writer and editor (books and periodicals); I also ran an organic smallholding at Frogditch Farm in Wiltshire.
1985	Hong Kong: Chief sub-editor at Specialist Publications, producing five regional periodicals -- Media, Travel Trade Gazette, two computer titles and a broadcasting journal (this was one of the first computerized magazine production systems in Hong Kong)

1981-84	Hong Kong-based freelance journalist, reporting on Hong Kong and South-east Asia for local, regional and overseas newspapers and journals. I also ran an independent on-farm research and development project in a traditional Chinese village on Lantau Island in Hong Kong for three years.
1980	Hong Kong: Managing editor at The Sun, a new daily newspaper, and then managing editor at The Star, an English-language daily with a Chinese co-edition.
1978-79	London: Freelance writer and sub-editor at various newspapers and magazines; reported Middle East and Third World issues
1977-78	Hong Kong: Night editor and then managing editor, The Star
1976-77	Cape Town: Sub-editor, The Cape Times; I decided to leave South Africa following the apartheid government's response to the Soweto uprising of June 1976 (the police shot an estimated 2,000 schoolchildren)
1975	Johannesburg: Chief sub-editor, Rand Daily Mail 'Extra' black townships edition
1974	Johannesburg: Music promoter in Soweto and the other Reef black townships, staged a series of mass open-air concerts, with recordings and movies
1972-73	Johannesburg: Sub-editor at The World, a mass-circulation black townships daily newspaper
1971	Travelling
1970-71	London: Sub-editor at the Press Association in Fleet Street; freelance sub-editor at The Sun, various weeklies
1969-70	Johannesburg: Sub-editor at The World, later at Post, a black (non-racial) national weekly. I was involved in black townships life and spent much of my time in Soweto, until I was arrested for being there without a permit, which started a police inquiry, and I left the country.
1967-68	Johannesburg: Reporter at The Sunday Express, a national newspaper
1966	Pretoria: Reporter at The Pretoria News
1965	Cape Town: Journalism School

Community development | Rural development

City farms | Organic gardening | Composting | Small farms | Biofuel | Solar box cookers
Trees, soil and water | Seeds of the world | Appropriate technology | Project vehicles

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Tai Long Wan: A traditional farming research and development project

by Keith Addison

Tai Long Wan village, Shek Pik, Lantau, Hong Kong, 1983-85

Stories by Keith Addison

Tai Long Wan
-- Tales from a vanishing village

Introduction

Tea money

Full story

Forbidden fruit

Full story

No sugar

Full story

Treasure in a bowl of porridge

Full story

In 1983, Keith Addison and artist-photographer Christine Thery rented an empty house in Tai Long Wan village from Fung Pak, the oldest man in the village.

In 1970 there were about 25,000 hectares of farmland growing rice in Hong Kong's rural areas; by 1983 there were only five hectares left, and two of them were in Tai Long Wan.

Weeding a rice field in Tai Long Wan

That's why we went there: this was one of the last intact examples of the old local traditional farming system. A great deal had changed in Guangdong Province in China where similar systems had been used, while Taiwanese and Southeast Asian traditional farmers used different versions of the basic Chinese farming system, and they'd also changed.

Tai Long Wan was a backwater -- the villagers all had their TV sets these days, but they'd had little to do with the modern world until the late 1960s. They were still living in the Ching Dynasty.

The farming system is rice-based, and in Tai Long Wan most of the bits and pieces of it were still in place, with a bit or a piece missing here and there, because it was winding down fast.

Tai Long Wan valley

Only two of the families still grew rice. Three-quarters of the village fields were fallow, three-quarters of the orchards on the hillslopes were run-down or overgrown.Half the sheds weren't being used, most of the families had sold their cattle, there were no pigs left. Only half the families kept chickens, there were only two geese, no ducks, and no

Hong Kong and Southeast Asia
-- Journalist follows his nose

Nutrient Starved Soils Lead To Nutrient Starved People

Full story

Cecil Rajendra
A Third World Poet and His Works

Full story

Leave the farmers alone
Bookreview of "Indigenous Agricultural Revolution -- Ecology and Food Production in West Africa", by Paul Richards

Full story

ponds. The villagers fished off the rocks and gleaned the shoreline pools for a constant harvest of seafood, but they had no boats anymore.

In 1970 there were about 120 people living in Tai Long Wan. By 1983 there were only 22: most of the younger villagers had moved to the city, leaving a village of grandparents and a few grandchildren. The whole middle generation was missing.

Many Third World villages have this problem, along with the labour shortage that goes with it, or the opposite problem: too many people, and not enough work for them. In the one you count hands, in the other, mouths.

By then an increasing number of Third World development workers were suggesting the traditional Chinese farming system was a better model for agricultural development in Southeast Asia and elsewhere than modern industrialized farming methods were proving to be.

As journalists we'd spent several years investigating and reporting on development issues in Southeast Asia. In a nutshell, this is what we'd found: modernization had helped nations to become not only self-sufficient in staple crops like rice, but exporters, while the numbers of poor, landless and malnourished people in their populations swelled into the millions at the same time, amid rampant environmental problems.

One of the last rice harvests in Hong Kong

We became increasingly interested in the Chinese model and in traditional farming systems in general as an alternative basis for development, and we had rather definite views on just what development meant, and what it didn't mean.

"Who benefits, and at whose expense?" we wanted to know. Don't always believe what they tell you in the city -- go and see for yourself.

This is what we knew of traditional farming:

Traditional farms may be "old-fashioned" but they can be highly productive, using methods which rely on locally available, renewable resources instead of expensive inputs from outside.

Traditional farming is usually well adapted to the local environment -- the traditional methods are sustainable.

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Traditional farms tend to be small. Contrary to popular belief, studies from all over the world show that small farmers usually produce more per unit of land than large farmers do: one-third more in India, 60% more in Thailand, and three to 14 times more in Latin America, according to the World Bank (World Bank, The Assault on World Poverty -- Problems of Rural Development, Education, and Health, Johns Hopkins University Press, Baltimore, 1975).

In spite of this, most rural credit and most rural development aid in the Third World goes to large farms, excluding the small farmers (although small farmers are usually a better credit risk, even in the US). This "trickle-down" approach simply doesn't work -- as usual, the rich get richer, at the expense of the poor and marginalized people the schemes are supposed to be helping.

Keith studying the locals -- the sight of a foreign devil actually doing something was almost as good as TV

Traditional systems are also flexible -- they can be adapted to a wide variety of local conditions, they make the most of local resources, they can absorb extra labour, or make do with not enough labour. Traditional vegetable farms in Hong Kong in the 1970s had 4.5 workers per hectare, in Thailand 3, in Malaysia 4.3, in the Philippines from 3 to 8, while brigade farms in South China used 21 workers per hectare.

So we went to Tai Long Wan to learn more.

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Tea Money

by Keith Addison

Tai Long Wan village, Shek Pik, Lantau, Hong Kong, 1983-85

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"What are you doing?" Ah Jeh asked suspiciously, keeping her distance.

It was a hot and sticky day and I was emptying a big compost bin in the yard, and getting filthy. But the main reason for her doubts was that she'd watched me filling the bin two weeks earlier, and she'd objected.

Drawing by Christine Thery

"It stinks!" she'd complained, wrinkling her nose.

It did indeed stink -- some of the kitchen waste I was mixing up with cowdung, weeds and other things had gone rotten. It didn't matter -- it stopped stinking as soon as it was in the bin, which didn't smell at all, and there are much worse smells than rotting kitchen scraps, such as that of the fermented nightsoil and urine Ah Jeh fed to her crops every week. She was being very fastidious, for an old peasant woman. She didn't go away though, she just stood there complaining about the smell until I'd finished the job.

This time she was standing clear, fearing for her nose.

"It's finished, it doesn't stink anymore," I assured her.

She approached and examined the black, crumbly, stinkless stuff.

"Good fertilizer," I told her. "Do you want some?"

"Yes, please," she said, and went off, returning with a basket to carry it in, and a bunch of dried spring onions "for Christine".

We often did things for Ah Jeh and she always gave Christine (not me) dried spring onions in return. Not that we wanted anything in return. But she liked it that way, and she had more onions than she needed. By now, so did we. I loaded two bucketsful of compost into her basket.

"No need to mix it with ash," I told her, "your fields have already got too much ash."

"Yes," she said, "thankyou," and carried it off, but instead of going to her main shed to store it she turned up the steps towards her cowshed, where she kept a big pile of ash from the mounds of crop wastes and weeds she burnt in the fields.

There was lots of clay in Ah Jeh's fields, and in everyone else's. It's great stuff for rice farmers, they use it to turn the place into a series of square ponds every summer and grow two crops of rice in all the mud.

But in winter they grow vegetables, draining the fields and building very neat raised beds with a hoe, lots of hard work, especially for old people.

Vegetables should have deep, rich soil to wriggle their toes in, but these vegetables hit an impenetrable clay pan about eight inches down, the remains of the rice paddy.

In good soil clay particles are like marbles jumbled together, with gaps and spaces in between for air and water and roots, and they also swap a lot of nutrients with the plant roots.

But the village soil was thin and acid. Instead of recycling their crop wastes to build up the soil fertility, the villagers burnt them and used the ash as a fertilizer -- in other words as plant food, not soil food. But ash

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contains a lot of salt, which turns the clay marbles into a layer of bricks that roots can't penetrate.

The vegetables grew well, but they weren't very healthy, and neither was the soil, so there were lots of pests and weeds, which meant lots more work.

So I was composting crop wastes instead of burning them, making soil food.

I shovelled the rest of the compost into sacks and started making the next batch.

Ah Jeh was a widow, and she lived alone. She grew other crops besides spring onions, but mainly to eat. To get her produce to the market in Tai O she had to walk to the bus stop, more than a mile from the village, mostly uphill, and she couldn't carry much because she was in her 70s and not very strong.

Like some of the other village women she had a permanent stoop, her spine buckling with age and too many years of hard labour. Even if she could have stood erect she would hardly have reached five feet, and she was slightly built.

She made the trip to Tai O every Saturday. Dried spring onions sold for HK$3 a catty (1.3 pounds), though fresh they fetched $5. But fresh ones were heavier and bulkier with their long green shoots -- she could carry more dried onions. It still wasn't much. With two baskets on a pole over her shoulder, Ah Jeh could only carry about 20 catties up the hill to the bus stop.

She was one of the few villagers who didn't have a cash reserve stashed away in a savings account. Twenty-five years earlier, the Government District Officer had arrived in a small boat, coming through the waves to the beach -- at the time the only way to get to the village that didn't take all day. He brought $670,000 in cash payment for a government land scheme, and shared it out among the family heads.

More than half the families used the money to move to the city. The dozen families that remained took up fruit growing, with the government supplying the trees, and made money, until the trees started giving out 10 years later because they cleared the orchard slopes and all the topsoil washed away in the summer rains. A few of the farmers became expert fruit growers and went on making money -- there were still some good orchards in the valley. But the younger villagers drifted to the city, leaving the old people behind.

Some of the villagers hardly bothered to farm at all. They lived as frugally as ever, spending very little, hardly touching their money. Excepting when their sons got married.

Ah Jeh spent the going rate of HK$40,000 on her first son's wedding, and another $40,000 on her second son's wedding. Then the second son wanted to open a restaurant in the city, so Ah Jeh lent him the rest of her money, but he lost it all. There was nothing left for the third son, and nothing for Ah Jeh.

So she had no choice but to farm. She worked in her fields and orchards for up to 10 hours a day. Two of her fields were covered with neat rows of spring onions in raised beds, with peanuts in a third field and mixed vegetables in a fourth. At one stage she had eight different crops growing in that field, in clever combinations. She worked well, with skill and knowledge.

But six more fields lay unused, her pineapple grove was choked with weeds, one of her two orchards was

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neglected and the other was marginal. She'd given up planting rice years before and, no longer needing their labour for the plough, she'd sold her cattle. Pigs were too much trouble for one woman, so she'd sold them too, and she no longer kept chickens. Without livestock wastes she didn't have enough fertilizer for the few fields she still worked, and none for the fruit trees. She used ash and nightsoil, and six inches under her raised beds was a pan of cemented clay.

Her third son, Wah Jai, stayed on long after most of the other young people had left. He was a good farmer and tried hard to make the farm work, but he failed, and left for a job in a car workshop in the city soon after we arrived in the village.

So we helped the old woman when we could.

She asked us for help the first time.

We were laying a water pipe to an old cowshed that Christine was turning into a photographic darkroom when we noticed Ah Jeh standing nearby, watching quietly.

Eventually, having apparently decided that we seemed to know what we were doing, she said: "Please, if you're not too busy, when you have the time, would you help me fix my shed? I'm not strong enough, and there's nobody to help me."

"What's wrong with it?" I asked.

"The roof is broken. Do you want to see it?"

The shed we were working on was at the end of a row of 10 adjoining sheds under one long roof; Ah Jeh's was in the middle of the row. The main roof crossbeam had rotted and collapsed, breaking two of the roof sheets. We were surprised none of the other villagers had helped her fix it, because if left to itself the damage would spread to the other sheds.

"None of the men would help you?" I asked.

"They're too busy," she said.

"Busy sleeping?" Christine laughed.

So we replaced the rotten section of the beam. But Ah Jeh didn't agree with the way we went about it, and she didn't stop saying so. But the roof would have collapsed if we'd done it her way. At first we reasoned with her, then we humoured her, and finally we ignored her, while her protests grew steadily louder and more pained.

We were standing behind the shed, levering up the new beam against the weight of the broken roof sheets so that we could prop it in place before securing it. Ah Jeh was supposed to be passing us bricks from inside the shed to use as props, but she'd lost sight of this in favour of her complaints, which had progressed to the general hardships of life and the difficulties an old woman faced and so on. Meanwhile I was struggling to hold the roof up.

Christine managed to find a brick and put it in place, and I released the crowbar. The roof failed to collapse. Ah Jeh droned plaintively on without a pause. We were suddenly convulsed with laughter -- we tried to bottle it up but a few giggles escaped, bringing a hurt silence.

"The roof's fixed now, Ah Jeh," I called to her, and she was happy again by the time we got round to the front of the shed, and full of thanks. Later she brought Christine two bunches of dried spring onions.

Some days later we tried to fix the broken roof sheets, which would leak in the rain, wetting the new beam and causing the same problem all over again. Ah Jeh couldn't afford new roof sheets, so we decided to patch up the old ones with sacking and tar, since she had some tar, at least waterproofing them a bit.

We collected a pile of brushwood on the high bank behind the shed and asked Ah Jeh to build a fire to melt the tar, while we cut the sacking to size. She'd been cooking over wood fires for 60 years, but she wouldn't light the fire.

"Why not?" asked Christine.

"No kerosene," said Ah Jeh.

So, just a bit indignant, I built the fire while Ah Jeh looked on. I got the kindling going, piled bigger sticks on top and fanned it with a board, but Ah Jeh, encouraging it from the other side with a stick, somehow managed to smother it, and it went out.

This happened three times. Each time I got the fire going Ah Jeh poked it to death with her stick. Then I removed her to a safe distance and sat her down on a stone. Muttering, I started all over again, not soothed by a glance of mutual amusement I caught the old woman exchanging with Christine, perched up on the roof.

"Not funny," I growled at Christine, who clearly didn't agree.

This time the flames leapt up without delay, I melted the tar and Christine poured it over the sacking she'd stuffed into the holes in the roof sheets. But we ran out of tar, with the job not quite finished.

"It leaks," Ah Jeh told us two days later, after a rainstorm.

It would always leak, no matter how much tar we put on it. What it needed was new roof sheets. The shed was like the rest of her equipment -- worn with age and use, patched, stitched and tied together well enough to last another year or two. She was rather like that herself.

Ah Jeh became our best friend in the village, and perhaps we were hers -- nobody else took much notice of her. She visited us every evening, which was always a pleasure. She was a gentle, gracious old lady. We both loved her.

I worked on at the compost, thinking of the old woman mixing up ash in her shed. The sun blazed down and I took off my t-shirt, working on in a pair of shorts. I finished sifting the cowdung, mixed in the other ingredients with a shovel, watered it, and had just finished loading it into the bin when two smart young Chinese couples came round the corner of the house. They stopped short at the sight of such a grimy gweilo, caked as I was with manure dust heavily streaked with sweat.

"Are you looking for somebody?" I asked. (It could speak!)

"We want to buy some lychees," one of the girls ventured.

"There aren't any lychees now," I said. "The season's over."

"Are you sure?" her boyfriend asked.

Ah Jeh reappeared with the empty basket, hoping for more compost.

"Ask her, she's a farmer," I said, and took the basket to refill it.

"No lychees," Ah Jeh told them. I gave her back the filled basket.

"What are you giving her?" the other man asked, in English.

"Compost," I said. "She hasn't got enough fertilizer, and she can't afford to buy any."

"Why not?" he asked.

"Why don't you ask her?" I suggested, so he did, and Ah Jeh, with the usual disarming village openness, told them why she couldn't make any money from her crops.

"Doesn't your family help you?" one of the girls asked her.

She told them her husband had died, leaving her with six young children, who had all left for the city as soon as they were old enough; the last one had left only months before.

"They only visit me at Lunar New Year," she added. They'd descended on her en masse with their spouses and children, 12 people, and she'd spent the four days cooking and cleaning for them.

"But don't they send you money?" the girl persisted.

"No," Ah Jeh said angrily.

Shocked, their friendly smiles gone, they stared at her: old and worn, abandoned

and alone, but still independent, still fending for herself.

I left them and went inside to clean up.

That evening there was the usual gentle knock on the door and Ah Jeh came in.

"Were those people friends of yours?" she asked.

"No," I answered. "They were tourists from the city."

She took a $100 note from her pocket. "They gave me this, and told me to buy myself tea in Tai O," she said, and laughed: "So I said, 'Thankyou!'" And we all laughed.

She looked at us tentatively: "Would you like to have tea with me in Tai O?"

"No, Ah Jeh," said Christine. "Thankyou, but you keep the money for yourself."

She took the note from the wrinkled old hand and tucked it back into Ah Jeh's pocket. Then we had tea together.

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Forbidden fruit

Tai Long Wan -- Tales from a vanishing village

by Keith Addison

Stories by Keith Addison

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It was a blazing hot Saturday, just before sunset. I was servicing my motorbike on the porch in front of the house when two youths, obviously from the city, stopped beneath an old custard apple tree overhanging the path nearby.

One of them leapt up and grabbed at a big custard apple, still too green to eat, but he missed and tore off part of a branch instead.

"Hey, take it easy," I called out, cautious in case the tree turned out to belong to his grandfather -- we two village foreigners didn't know all the children of the valley who lived in the city now, spending only the occasional weekend in the village.

"What?" one of the youths responded, as the other leapt up again, succeeding this time in plucking the fruit.

"Are you camping on the beach?" I asked.

"Yes," the lad said. Strangers after all. I'd have stopped them if I'd known -- and saved them a lot of trouble, as it turned out.

"Who said you could take that fruit?" I asked, but they scowled at me and started to walk off, muttering something about *gweilos* -- foreign devils.

City kids celebrating the joys of nature at Tai Long Wan

The villagers suffered constant losses from city kids who came to camp on the beach and often raided the orchards, stealing fruit and damaging fences and trees.

All exits to the orchards and cropfields from the public path leading to the beach bore signs in Chinese saying such things as "Tourists -- stop!" and "Keep out -- trespassers will be fined $1,000 or given a big smash!" But the raiders struck late at night and were seldom caught.

But this was broad daylight. The Widow Fung, returning late from the fields carrying her hoe over her shoulder, had also seen what had happened and she hastened forward to stop the thieves, but the two lads made off.

Her piercing yells attracted other villagers, and some of the visiting village youngsters chased after the two youths and brought them back.

"How dare you steal our fruit?" the Widow Fung demanded.

"We didn't know," one lad said. The other, still holding the custard apple, pointed at me and said: "The gweilo said we could take it."

"Don't tell lies!" the old woman shouted angrily. The dismayed youths shrank back.

"Who's tree is it?" asked Ah Fung the Shopkeeper.

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"Fung Pak's," said the Widow Fung -- our landlord's, Grandfather Fung.

Two of the children ran off to call Fung Pak, but the old man was eating his dinner and told them to keep the two youths there at the vandalized tree until he was finished, which they did with glee -- it's a real treat for 10-year-olds to be put in charge of 18-year-olds. The youths accepted this humiliation with poor grace.

I went on working on my bike.

Eventually Fung Pak emerged from his house at the end of the row and ambled through the village to confront the wrongdoers.

"Why did you steal my fruit?" he asked.

"We didn't know," pleaded one, while the other, still holding the fruit, said again: "The gweilo said we could."

"Nonsense!" old Fung told him. "You knew it wasn't yours," he told the other. There was no reply.

Fung Pak nets a swarm of wild bees in his tree

The old man held out his hand: "One hundred dollars."

"Why so much?" they protested. "For one fruit!"

"If you buy it, the price is one dollar. If you steal it, one hundred dollars. That is the rule."

"But we haven't got one hundred dollars!" they argued.

"Then you will come with me." He took the youth holding the fruit by the wrist and marched him off towards his house. The lad tried to twist free but the old farmer was much the stronger. His captive squirmed and complained, until the old man turned and bellowed at him like an angry bull, bringing immediate submission.

All the villagers in the top row were sitting on their porches or on the benches opposite the houses watching, and they berated the youth as the strange duo passed by.

"Thief! Who do you think you are?" shouted Mrs Fung the Shopkeeper's Wife. The Widow Fung in the next house said something very rude, and they all laughed as the youth cringed with embarrassment. Ah Fung the Basketweaver was scathing about the moral virtue of these young people of today, and Mrs Fung the Mother of 12 gave a particularly spirited performance, even for her, with Ah Fung the Other Shopkeeper and his teenage daughters butting in to agree.

The other youth meanwhile ran down the path to the beach and soon returned with the rest of the group, six youngsters. Ignoring the

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villagers' derisive comments, they marched to where Fung Pak was sitting on his porch waiting for them, still holding the unhappy thief by the wrist.

I wondered whether the old man would need help as they crowded onto the porch, blustering and shouting, pressing in upon him, waving their arms threateningly. But he picked up a hammer and swung it over his head, roaring ferociously. The campers fled -- except for the thief, who didn't dare move.

Waving the others back, the group leader gingerly approached the porch and began arguing the case. Sitting with Mrs Fung the Shopkeeper's Wife at the other end of the row, I couldn't hear what was being said, but I kept hearing the word "gweilo", so I stepped up to settle that line of argument.

"Is your friend still saying I told him he could take the fruit?" I asked the leader. "Why doesn't he stop lying and admit he was wrong?"

"Yes, he was wrong," the leader decided. "But $100 is too much, he hasn't got $100, he is only a student."

"Student!" Fung Pak snorted. "Why is he so stupid then?"

This brought peels of laughter from the villagers.

"Well, he must pay," I said.

"But he is a student, he has no money!"

"Mr Fung is a farmer, he has even less money," I said, with loud agreement from the villagers, "and your friend has stolen his fruit."

"But it is too much..."

"He can pay, or Mr Fung will call the police and he will be arrested for theft," I said.

"That's right," said Fung Pak. "I'll put him in handcuffs." He pointed to an awful-looking steel hook affair lying on the table, vaguely resembling a handcuff. The culprit wilted visibly. I'd seldom seen anyone wearing such an obstinate expression as old Fung's. Meanwhile Mrs Fung the Mother of 12 was telling the other campers what she thought of them. She was really good at that (as I knew well!) -- they kept wincing, their bravado steadily sagging.

"I'm sure his friends will help him pay," I suggested to the group leader, and turned to go, nodding to Fung Pak -- who gave me a mischievous grin that no one else saw. He wasn't really angry at all, it was just a sham.

The villagers kept on making rude remarks at the group of campers standing nearby, who didn't respond, but they were smarting.

In fact the custard apple was just an excuse to cause a bunch of city kids serious loss of face, as well as teach them a lesson. Yet these old villagers were about the most placid people you could wish to meet, why were they being so vengeful?

Their patience had simply run out, long ago already. It wasn't just the fruit. One night visiting kids had set up camp -- four tents and a barbecue -- in one old woman's peanut field, where she found them the next morning, the field flattened and the crop destroyed, and when she complained they jeered at her.

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Another group set fire to some grass, and the fire swept through four fields, a patch of bananas and two bamboo thickets before the farmers could put it out. There was a long list of such incidents.

The really stupid part of it was that the city kids weren't even supposed to be there. Camping on beaches was illegal, excepting in designated camping areas in a country park, and this beach was neither -- the country park boundary followed the Water Department road well above the village, the valley and the beach.

This hadn't stopped the Country Parks Division featuring the valley and the beach in the cover photograph of a leaflet on the country park handed out to all comers at the Mui Wo ferry pier.

"Why did you put that photograph on the cover?" I once asked them. "It isn't in the Country Park."

"But it's a nice photograph," was the reply.

So the campers kept coming.

Most villagers went to bed early, getting up at 6 am to start another hard day, and outsiders were banned in the village after 10 pm, but groups of campers often arrived at 2 or 3 am, up to 20 young people heavily armed with barbecue forks and pretending not to be terrified of the dark, shouting loudly, flashing their torches everywhere and using multiple industrial-strength portable stereos to frighten off all the evil spirits.

The men were often called from the fields, or from their beds, to keep control. They'd each take a five-foot length of one-inch-thick steel waterpipe and set off in strength to force a group of campers to pay for the damage they'd caused, or to evict them from the valley. They'd often asked me to join them. They never hurt anyone though.

Most city youngsters thought the old farmers were uneducated, primitive, ignorant old fools and treated them like dirt. A jeering bunch of city kids shouting "Monkey! Monkey!" had once thrown stones at Mrs Fung the Mother of 12 as she worked in one of her fields.

Now the villagers were getting their own back.

The counsel for the defence was making no impression on the judge and jury. "If he can't pay, he can stay here until he starves," old Fung growled.

In fact he could pay -- the money was in his pocket all the time, and somehow the old man knew it. When their resistance finally collapsed, the lad paid up without any help from his friends, and Fung Pak let him go. He even let him keep the custard apple.

Sullen and resentful, the humiliated youths slunk out of the village and back to their camp on the beach. The villagers watched them go in silence.

At sunset, laden with rucksacks and barbecue forks, their stereos silent, they trailed back through the village and out of the valley on their way to the bus stop. They wouldn't be back. Nor would any of their friends.

A few days later Fung Pak started clearing the heavy growth of

weeds from under the custard apple tree, and the orange tree and two small lychees growing beyond it. He dug up all the weeds and banked rocks around the trees to hold more soil.

"Too much work," he told me, taking a rest under the orange tree. "And no use here next to the path -- people will just steal the fruit."

"No, no," I said, "you'll be a rich man." I began counting off the little green oranges on the tree: "$100, $200, $300..."

He slapped his thigh and bellowed with laughter.

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No sugar

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-- Journalist follows his nose

Food comes first, and the villagers have got their priorities straight. They don't say "Hello," they say: "Have you eaten yet?" They always eat at the same times, so there's no surprise in the answer.

Until we arrived. We were always busy and usually ate when we had the time, unless we got hungry first, and suddenly the meaningless question gained a whole new level of interest: "What? You haven't eaten yet?" They couldn't believe the weird times we had or hadn't eaten, it caused a lot of talk.

One winter day at about 1pm Granny Fung the landlady popped her head in the kitchen window, something she did most days in the hope of a snack (she was the only villager who liked our food), and said the usual thing: "Have you eaten yet?"

Granny Fung -- *Drawing by Christine Thery*

"No," I said, but Christine, in the same breath, said "Yes." I stared at her in surprise. (I'd just finished a long telephone conversation and she'd got hungry and had some lunch.)

Granny Fung couldn't believe it, it was the funniest thing she'd ever heard -- she shrieked with laughter: "You've eaten," she spluttered, "but he hasn't!" And she went off, still cackling, snack forgotten, to tell the neighbours.

"That made her day," said Christine, laughing.

"But I wanted to talk to her," I said. "Her lettuce crop is ready and we want some."

So we followed the old woman and found her at the Widow Fung's house, both of them shrieking with laughter. And of course the Widow Fung had to ask the question too, and got the same answers. When they'd quietened down a bit we asked Granny Fung if we could have a couple of her lettuces.

Nutrient Starved Soils Lead To Nutrient Starved People

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"Sure," she said. "Come down to the field and I'll get some for you."

And the Widow Fung, in an untypical fit of generosity, gave us some of her baak choi and choi sum, fresh-picked that morning. "Very sweet!" she said.

Chinese white cabbage -- baak choi (Geoffrey Herklots)

We thanked her and followed Granny Fung down the path to her vegetable field, where she and old man Fung worked so hard every day. The usual beautifully made raised beds had neat rows of lettuce, baak choi, choi sum, Chinese kale, gourds, and they'd just been watered that morning. They let the water in from the irrigation ditch at the top of the field and it flowed neatly down the first path, irrigating the beds from the side, back down the second path, and so on right through the field, never pausing or puddling, flowing out again at the bottom corner into another irrigation ditch.

All the villagers seemed able to get that perfect flow in their fields without even trying, even though they remade the beds several times a year.

We'd tried it in one field after making our first raised beds and paths: the water flowed halfway down the first path and stopped, puddled, trickled on a bit further, stopped again, backed up...

We tried fixing it but that only made it worse, and we got very muddy, so we gave up and went for permanent no-dig beds instead, using lots of organic matter and mulch, which worked better anyway and was much less work. That didn't stop us admiring the villagers' skill though.

We reached the Fungs' lettuce bed. "How many would you like?" she asked.

"Two please," said Christine, so she pulled up two nice ones and gave them to Christine. Chinese lettuce is loose-leafed and the villagers pull them

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up roots and all rather than cutting them like baak choi, and this was why we wanted them -- we wanted to regrow them.

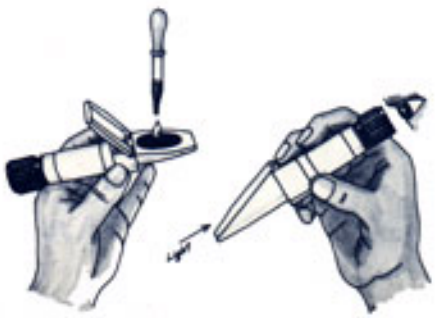
We thanked her and took the lettuces home, along with the Widow Fung's choi. In the kitchen, we sliced the lettuce leaves off just above the root, and Christine tested them with our new refractometer while I took the two roots to the chicken shed where we made our compost and replanted them in pure earthworm castings, which is about the best soil there is.

Flowering Chinese cabbage -- choi sum (Geoffrey Herklots)

Refractometers measure the percentage of sugar in plant juices (the "Brix" level) -- you put a leaf in a garlic crusher and squeeze some juice out onto the slide, and hold it up to the light to get the percentage.

Well, so what, who needs more sugar anyway? For one thing, this is real sugar, not that whiter-than-white poison in the sugar bowl, and for another, a plant's mineral and protein content, and protein quality, are directly related to the sugar content in the sap. So the refractometer is a reliable, quick and cheap quality test. It's also been shown that plants with high sugar levels are much less prone to pest attack -- healthy, well-fed plants have good resistance, like healthy, well-fed people.

Standard sugar levels have been worked out: for lettuce, 4% is poor, 6% average, 8% good and 10% is excellent. (See list below.)



Granny Fung's lettuce measured 1.5%, worse than poor -- empty, hardly worth eating. The Widow Fung's baak choi also measured 1.5%, and the choi sum 2% -- not "very sweet" after all.

That made us sad -- they worked so hard, for such poor results. But we weren't very surprised, though we hadn't expected it to be quite so poor.

The soil was poor, and the villagers' soil maintenance methods were also poor.

Old man Fung and his old wife were fairly typical. They were well into their 70s and they were alone: their six children had left the village, and they lacked the strength and the labour to continue with the old methods. Weeds and crop wastes were once dug into the soil, but now they were burnt to ash, and the ash used as a fertilizer.

They'd always burnt rubbish and used the ash, but now that they burnt everything, no organic matter was being returned to the soil. They'd sold their cattle and pigs long ago when they gave up growing rice, and now they only had a few chickens, so they had no manure, except their own, which they diluted and fermented in big earthenware urns before diluting it further and sprinkling it under the plants, which supplied some nutrients, but not organic matter.

The ash and nightsoil wasn't enough, so they made up for it with chemical fertilizers, which still wasn't enough, and did nothing at all for the thin, over-ashed, undernourished soil. So they had pest problems -- such weak plants are a beacon for pests -- and they also had weed problems, since nature insists on repairing such poor soils by growing weeds in them.

We reckoned that the villagers could cut a lot of labour by making permanent, deep beds and composting the crop wastes rather than burning them, to build up the organic matter in the soil again and give it some life. This would also cut the weed and pest problems, saving more labour and the expense of fertilizers and pesticides. The earthworm composting system we were using, apart from being quite simple and producing a high-quality product, also produced a lot of excess worms which made fine chicken-feed -- the village chickens were also in poor shape, though the feed bills were high (higher than the value of the eggs).

We hoped this lettuce test would show us whether we were on the right track or not.

A few days later one of the two roots pushed out a sprout, which grew into a lettuce, which we cut and tested it with the refractometer. It's no way to grow a lettuce, pulling it up, cutting it off and replanting it like that (the second one just died of fright), and a plant's potential is set early in its life, but nonetheless, the new lettuce measured 7% -- not excellent, but not empty either.

So there was nothing wrong with the lettuce that a good soil couldn't put right. We went ahead with the composting work and the no-dig beds.

Chinese lettuce (Geoffrey Herklots)

We also tested as many different lettuces as we could find, from other fields, from other villages, from rural and city markets, from supermarkets. A lettuce from China measured 2%, a HK$9.50 import from California, 2.5%, a luxury lettuce flown in from Paris, costing $22, also measured 2%. Nowhere could we find a lettuce that even rated "poor".

In fact we could hardly find any vegetables that had anything in them: baak choi, 1.5%, choi sum 3%, Californian celery 3%, Australian tomatoes 4%, US tomatoes 4.5%, Chinese bell peppers 4%, local cauliflower 3.5%, American cabbage 4.5% -- all poor or worse.

Broccoli, carrots, spring onions and sweet potatoes tended to be somewhat better, but not reliably, and nothing was "excellent". Nothing but bad news: nearly all available vegetables are very poor quality.

Healthy salads

Lettuce is good for you. It's the basic salad ingredient, it's recommended for its high calcium content to people with an intolerance for dairy products.

According to a textbook on nutrition, 100 grams of lettuce contains, among many other things, 77mg calcium, 30mg phosphorus, 2.3mg iron and 10mg vitamin C.

An average-sized lettuce will give you half your daily requirement of calcium, a fifth of your phosphorus, all your iron, and a third of your vitamin C. (Though actually the vitamin C level plunges to about half within an hour or two of picking.)

But another textbook gives different values: 44 per cent less calcium, 40 per cent more phosphorus, 74 per cent less iron and 20 per cent less vitamin C. Two other books give calcium values for lettuce only a third as high as the first book.

There are other, more extreme, variations: the calcium value for cabbage in the second book is 224 times higher than in the first book.

Such wide variations seem to be the rule. When two tomato crops of the same variety but grown on different farms were analysed, one was found

Severe pest damage to a village crop of baak choi

to contain twice as much phosphorus, three times as much potassium, five times as much calcium, six times as much cobalt, six times as much boron, 12 times as much magnesium, 53 times as much copper, 68 times as much manganese, and l,933 times as much iron as the other.

There was no visible difference, no way of choosing the good tomatoes.

So much for the balanced diet. Lettuces are healthy food? -- which particular lettuce is that?

What matters is where it's grown, and how: if it's grown in dead soil with harsh chemical salts as a substitute for natural fertility it's not going to contain much of anything worth eating -- it won't be healthy and eating it won't make you healthy.

But even good soil is no guarantee of quality. A lot of modern food plant varieties are hardly worth eating no matter how they're grown, because they're engineered that way: they lack the ability to take up important nutrients even when the soil has them.

Corn (maize) is a useful plant: it has a good protein-carbohydrate balance and a good spread of minerals -- if it's old-fashioned "open-pollinated" corn, that is. But if it's a modern hybrid variety it will probably be severely short on vital trace elements, and some may be lacking altogether.

Though they require only minute doses, plants need at least 40 different trace elements (iron, manganese, boron, zinc, copper, cobalt, molybdenum, etc.) without which their metabolic processes, particularly their enzyme systems, can't function properly -- and neither can ours.

Simply put, hybrids are crosses between different strains that have been inbred (forced to self-fertilise); the result is a plant that puts the energy that should go towards reproducing itself into extra growth instead. So hybrids are big yielders.

But when a natural, open-pollinated variety of corn was tested against 4,000 hybrid samples grown across 10 states in the US, the hybrids had an average of only 20 per cent of the nutrients of the open-pollinated corn. All the hybrids tested were short on trace minerals, and none contained any cobalt, which is the core element of vitamin B12.

We need cobalt to form haemoglobin in the blood, and to prevent nerve

degeneration. Vitamin B12 deficiency can cause weakness, permanent nerve damage, pain in the extremities, liver enlargement, skin problems, and more.

But it's quantity that pays, and hybrids account for 98 per cent of the US corn crop today. This is mostly field corn used for stock feed (which doesn't say much for the quality of the meat) but the same thing applies to sweetcorn. And it's not just in the US -- natural corn is now universally rare.

In theory, hybrids are not necessarily all bad -- it depends on which particular traits they were developed for. In practise though, they are generally developed for bulk. Nutritional value is ignored.

It is not that open-pollinated corn can't compete. What it lacks in bulk it makes up for in protein content, and it's been found that livestock eat less of it and thrive better. And, when properly grown, well supplied with trace minerals and with its enzyme systems functioning properly, it can, like all healthy creatures, defend itself against pests and disease and doesn't need huge and repeated doses of powerful poisons to survive.

Commercial crops of onions, celery, carrots, cabbage, cauliflower, broccoli, brussels sprouts, tomatoes, cucumbers, squashes, pumpkins, sweetmelons, bell peppers, aubergines, and particularly wheat and rice are now increasingly hybridized -- and likely to be nutritionally empty.

Whether hybrids or not, virtually all commercially grown vegetables are heavily chemicalized. Reliance on chemical fertilizers has led to a massive decline of soil fertility.

Sick soils produce sick plants, and today's pest-prone crops are sprayed up to 40 times from seed to harvest. Many of the pesticides are fat-soluble, which means they can penetrate the plant tissue and cannot be washed off -- they're *inside* the plant. (It's estimated that 64% of the heavy doses of pesticides applied to commercial wheat crops survive in the baked loaf of bread.)

So your healthy salad almost certainly lacks nutrients -- but not poisons.

(1984)

Refractometer readings

Plants	Poor	Average	Good	Excellent
Alfalfa	4	8	16	22

Apples	6	10	14	18
Asparagus	2	4	6	8
Bananas	8	10	12	14
Beets	6	8	10	12
Bell Peppers	4	6	8	12
Broccoli	6	8	10	12
Cabbage	6	8	10	12
Carrots	4	6	12	18
Cantaloupe	8	12	14	16
Cauliflower	4	6	8	10
Celery	4	6	10	12
Cherries	6	8	14	16
Corn stalks	4	8	14	20
Corn (Field)	6	10	14	18
Corn (Sweet)	6	10	18	24
Endive	4	6	8	10
Peas	8	10	12	14
Grains	6	10	14	18
Grapes	8	12	16	20
Grapefruit	6	10	14	18
Green Beans	4	6	8	10
Honeydew	8	10	12	14
Hot Peppers	4	6	8	10
Kohlrabi	6	8	10	12
Lemons	4	6	8	12
Lettuce	4	6	8	10
Limes	4	6	10	12
Onions	4	6	8	10
Oranges	6	10	16	20
Papayas	6	10	18	22
Parsley	4	6	8	10
Peaches	6	10	14	18
Peanuts	4	6	8	10
Pears	6	10	12	14
Pineapples	12	14	20	22
Potatoes	3	4	6	7
Raspberries	6	8	12	14
Rice	4	8	12	16
Sorghum	6	10	22	30
Soybeans	4	8	12	16

Squash	6	8	12	14
Strawberries	6	10	14	16
Sweet potatoes	6	8	10	14
Tomatoes	4	6	8	12
Turnips	4	6	8	10
Watermelons	8	12	14	16

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Treasure in a bowl of porridge

Tai Long Wan -- Tales from a vanishing village

by Keith Addison

Stories by Keith Addison

Tai Long Wan
-- Tales from a vanishing village

Introduction

Full story

Tea money

Full story

Forbidden fruit

Full story

No sugar

Full story

Diary, June 1983: Rice seed

A development project run by friends in the Philippines reports a setback to their plans to put 20 hectares under native strains of rice, fertilised with worm castings from a large-scale annelidic composting project they've set up which recycles 20 tons of organic wastes a day into high-grade compost.

They say the native strains, developed over hundreds of years to suit local conditions and resist local pests and disease, could, if properly fertilised, equal the yields of the new "Green Revolution" high-yielding dwarf hybrid strains, with better nutritional content, and without the expensive and dangerous chemical inputs which the hybrids need to survive -- and which only the rich farmers can afford.

This hard fact, that only the rich and influential have access to the new techniques, is the main reason that the Green Revolution has usually meant greater production on the one hand, and more starvation on the other.

In the Philippines, though agricultural production had grown by 3 to 4% a year, average real daily wages in agriculture in 1974 were only a third of what they'd been in 1965.

In 1977 the government declared the Philippines to be self-sufficient in rice, and no rice was imported that year. In 1982, 200,000 tons of rice were exported.

But even the official statistics, which generally favour the official line, show a different picture: half the deaths recorded annually are of children under five; of the country's nine million children under six, less than a third have normal growth rates and more than a third are actively malnourished -- that is, suffering from serious diet deficiencies; of children from one to six, 75% are anaemic, 75% are deficient in vitamin A; more than a third of school-aged children are malnourished.

Elsewhere the picture is similar. In Mexico, home of the Green Revolution, early childhood death from malnutrition increased by 10% between 1968 and 1978. Green Revolution production increases in Bangladesh saw 15% of the rural households increasing their incomes, while the number of rural households classified as poor increased by a

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Hong Kong and Southeast Asia
-- Journalist follows his nose

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third, and those classed as extremely poor increased five-fold.

The number of landless labourers meanwhile increased by 225% -- not because of uncontrolled population growth, but because of the mechanization that goes with the Green Revolution, and the fact that the rich farmers, who alone could afford to mechanize (subsidies and credit are often specifically confined to large farms), needed to expand their farms to pay for their new machines, and did so by evicting their tenants.

In India's Punjab, a fairly typical case, newly mechanized farms expanded by an average of 240% in three years, at the expense of small farmers. In the first decade of the Green Revolution in India, the number of cultivators decreased by 15 million, and the number of landless agricultural labourers increased by over 20 million, while mechanization meant that the number of jobs declined. Starvation, therefore, increased.

Throughout the Third World, the burgeoning of the rural landless has far outstripped the population growth -- even though the landlessness figures do not include the very many who have been forced to leave the rural areas for the squatter towns that have formed around the main cities.

So, by increasing the yields of native varieties through improved waste recycling methods and better soil maintenance techniques, the Philippines project hopes to strengthen the hand of peasant farmers in resisting -- or surviving -- this onslaught of "development".

They're not motivated by woolly nostalgia for the quaint old ways of the past, nor by anything other than practical considerations, since it is clear that modern industrialized farming, with its reliance on energy-intensive and capital-intensive techniques, its over-specialization, its artificial division between crops and livestock, extensive land use, heavy reliance on environmentally damaging chemicals, the poor nutritional quality of its products, and its failure to maintain soil fertility, is not sustainable, neither in the Third World nor even in the industrialized nations.

What, then, is sustainable? Smaller farms, for a start. Smallholdings generally outproduce the big farms. In India, the smallest farms produce one third more than the larger farms. In Thailand, plots of two to four acres produce 60% more rice per acre than farms of 140 acres or more. In Taiwan net income per acre of farms of less than 1.25 acres is nearly double that of farms over five acres. According to the World Bank, small farms in Argentina, Brazil, Chile, Colombia, Ecuador and Guatemala are three to 14 times more productive per acre than the large farms.

This phenomenon is not confined to the Third World. A study in Britain found that the output of food per unit area of the average house-and-garden plot is greater than that of the average commercial

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farm -- though only 14% of the house-plot area was used for growing food.

In the US, the average net income per acre for family farms was greater than that of large farms in 12 out of the 14 years up to 1975.

More important than volume and value of production is fertility maintenance, and history shows that the farming pattern that can best achieve this is that of the small, mixed, diverse, intensive farms which peasants the world over have traditionally favoured.

The only reason such farms have not proved "viable" in the modern era is that they have been shoved onto the sidelines in favour of the big, specialized, extensive farms, which in the past have nowhere proved viable in the long term. Nor will the modern chemicals make all the difference this time -- rather, they are hastening the decline.

It seems that big, specialized, extensive farms only develop when speculative interests come into contact with food production. Their interests are short-term. Peasants, however, cannot afford to take risks, not even in the long-term -- their methods have to be sustainable.

And so they are. Nor has modern technology discovered any other way of doing it: methods can be and have been greatly improved, but not the system itself.

Real rural development, as opposed to elitist schemes like the Green Revolution, should concern itself with bringing the resources of research and technology to bear on improving the peasant systems rather than replacing them.

There are no ready-made recipes for this. It certainly involves more than a bunch of fancy new seeds and an array of poisons. The existing structures must first be studied and understood before changes are proposed. It takes time and care, but excellent results can be achieved -- just by applying modern techniques to traditional waste recycling systems, for instance.

What cannot be achieved this way, though, is corporate profits for agribusiness and chemical multinationals, rakeoffs and contracts for city politicians, and political favour bought from rural elites with easy credit and big subsidies.

Thus the native rice project in the Philippines.

But they've only managed to find two kilos of native seed in the entire province.

Zebra Crossing
-- On the wrong side of South Africa's racial divide.

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Presuming their two kilos has a good proportion of viable seed, they'll need to plant two successive seed crops before they'll have enough seed for 20 hectares.

It wasn't clear whether the two kilos they found was all of the same or of several varieties. They would have found hundreds of varieties there a few years ago, but now there's nothing but IR36 Green Revolution dwarf hybrids from the International Rice Research Institute (IRRI).

This is called mono-gene domination. The old way of genetic diversity meant that an attack of disease or pest would hit one variety in a few areas, but all the other varieties would survive. Mono-gene domination means putting all your eggs in one basket, so that any pest or disease which develops an immunity to the pesticides, as they invariably do, and penetrates the plant's own built-in resistance, can wipe out an entire national crop.

It happens. The response to the introduction of the hybrids, with their heavy reliance on an artificial environment of chemical fertilizers and pesticides, was what IRRI termed "an unexpected buildup" of pests and diseases which quickly developed resistance to the pesticides.

The answer was stronger doses of pesticides, and then new, stronger, pesticides. But that's no answer -- rather the opposite, since the major effect of the tremendous modern growth in the use of toxic pesticides has been to cause pest problems.

The trouble is that the pesticides tend to kill everything, friend and foe. They kill aphids, but they also kill ladybirds, which eat lots of aphids, and the whole delicate balance between predator and prey is disrupted. Pests tend to develop resistance to pesticides quicker than their predators do, since there are usually far more prey than predators, and thus more individuals with an inheritable resistance. These survive and multiply, so that the sprays kill progressively more predators and fewer pests. As a result, to take one example, 24 of the 25 most serious crop pests in California are either insecticide-aggravated or actually insecticide-induced pests.

The red spider mite is a good example of an insecticide-induced pest. Thirty years ago it was a minor pest, but repeated use of pesticides aimed at more important pests decimated its natural enemies and competitors, and now the red spider mite is a serious pest problem worldwide.

Thus, despite elaborate chemical protection, the 1972 mono-gene hybrid rice crop in the Philippines was ravaged by an epidemic of tungro virus, carried by little insects called leafhoppers, which had become resistant to

the latest poisons being used. In 1974-75, a million acres of hybrid riceland in Indonesia was devastated by viral disease. The hybrids are currently threatened by 23 pests and diseases.

One other means of protection is used: breeding new resistant strains -- resistant to pest attack, and resistant to the incredible dosages of pesticides now required. This isn't working out too well either: just as the rate at which pests develop resistance to insecticides has accelerated to meet the ever-greater doses of ever-stronger poisons, so too the new resistant varieties are succumbing and being replaced faster and faster.

According to Dr Garrison Wilkes, a specialist in plant genetics at the University of Massachusetts, it is only a matter of time before a disease mutates and attacks a new seed strain. Wilkes puts a major disadvantage of the Green Revolution into perspective. The hybrids do not "breed true": seed saved from a hybrid crop will not reliably produce a successive crop, and new seed must be bought each year.

"In their wilderness state, both plants and the diseases which attack them are forever adapting to each other through the evolutionary process," Wilkes says. "The diseases mutate new forms of attack, the plants new forms of resistance. But under modern agriculture plants no longer mutate but are grown from new seeds each year for continuous high yields. The mutation of diseases, however, cannot be stopped."

And here's the crunch: where does the genetic material for the new strains come from? From the old native strains that the hybrids have all but wiped out.

This ludicrous situation is not unique to rice. It affects virtually all human food crops.

Historically, over 3,000 species of food plants were cultivated, half of them in sufficient quantity to enter into commerce. Today 85-90% of human nutrition comes from only 15 plant species, eight of which account for three-quarters of humanity's food. Three crops -- wheat, rice and maize -- account for more than three-quarters of the total cereal consumption, and these crops are now vulnerable because of mono-gene domination, thanks to the "miracle" seeds.

Of which the US National Academy of Sciences reported: "The process repesents a paradox in social and economic development in that the product of technology [the new seeds] displaces the resource upon which the technology is based."

What happens is that the farmers changing over to the new seeds -- as well as those forced out of business by them -- tend to eat their old seed,

and unique strains that have taken hundreds of years of careful selective breeding to develop vanish -- often, as one researcher said, in a single bowl of porridge.

The disastrous aspect of this is not so much that it happens, but where it happens. The world's major crop varieties are not ubiquitous. Almost all our food plants developed in eight major and three minor centres of extreme plant gene diversity ("Vavilov centres") where, because of climate and topography, life continued to flourish and diversify while the temperate zones were in the grip of the ice age. These centres represent only a fortieth of the world's land area, and all are in the Third World.

The Irish Potato Famine of the late 1840s was caused by the fact that English explorers brought back only one variety of potato from the Caribbean. Planted everywhere in northern Europe, it was only a matter of time before such a genetically uniform crop would be struck by blight. Today, despite major efforts to diversify potato varieties, Europe is still vulnerable and in need of additional genetic material.

Which is to be found in the Vavilov centre in the Andes, where there are hundreds of potato varieties. Or there were: their fate seems to be in some doubt since the International Potato Centre in Peru announced that a large proportion of the varieties collected over the previous 50 years had been lost, leaving an inadequate sample of cultivated potato species in existing potato gene banks.

The gene banks themselves are not that reliable: one of South America's largest collections of corn germ plasm was lost when the compressors for the refrigerators in which it was stored failed.

The world's storehouse for many major crops is the US National Seed Storage Laboratory at Fort Collins, Colorado. The laboratory is insufficiently funded, and stands, above-ground, between one of the country's largest munitions manufacturing plants and a nuclear reactor. The collection is not protected against blast or radiation.

The US National Academy of Sciences concludes: "After weighing all available measures of preserving endangered species [of crop plants], we are repeatedly forced to the conclusion that the only reliable method is in the natural environment." In other words, growing on farms.

So what of all the varieties of potatoes growing in the fields of the Andean peasants whose ancestors developed them? Nobody seems to know, but one wouldn't say they were any more secure than the peasants who grow them, and ubiquitous development programs like the Green Revolution have not contributed to the security of peasants anywhere.

Virtually all crops are in the same situation. The US cucumber crop depends on new material introduced from Korea, Burma and India. North American lettuces depend on material from Turkey and Israel. US beans contain disease-resistant traits from Mexico, Syria, Turkey, Chile and El Salvador. The US Department of Agriculture states that the US spinach crop has "been rescued repeatedly" from disaster by new material from India, Iran, Turkey and Manchuria. Were it not for a Turkish variety brought to the US in 1948, US wheat farmers would lose at least another US$3 million a year to stripe rust. The sorghum crop was rescued by an Ethiopian strain. North African material saved the Canadian prairie oat crop. "Barley yellow dwarf", a new disease of barley, is blocked worldwide by a single Ethiopian gene.

Thus the future of the world's food supplies depends, as it has always done, on the Vavilov centres. But evidence is mounting that the centres are rapidly being destroyed.

The uncounted varieties of wheat traditionally grown in Afghanistan have largely vanished, replaced by the genetic uniformity of dwarf hybrids. Unique wheat varieties grown in Greece -- genetic material vital to the French, Argentinian and US wheat crops -- vanished when the introduction of dwarf hybrids to the rich farmers in the valleys drove the hillside farmers out of business.

The genetic erosion of wheat in its centre in the Near East has been so rapid under the advance of the Green Revolution that Dr Erna Bennett of the UN Food and Agriculture Organization (FAO) Crop Ecology Unit, and other FAO scientists, anticipate the complete loss of the Near East Vavilov centre, with severe implications for world wheat crops.

Wheat is the world's foremost cereal. Rice, the second most important cereal, is in a similarly vulnerable situation. It is this erosion that the Philippines native seed project has encountered.

A similar thing has happened in Hong Kong -- not the erosion of genetic diversity by the introduction of new seeds, but the simple destruction of rice farming. Twenty years ago about 9,000 acres were under rice in Hong Kong. Now the total is said to be only 10 hectares, but there is probably less than that.

One local variety grown in Shatin was famous: at one stage the entire harvest was reserved for the imperial court in Peking. No rice is grown in Shatin Valley now. There are still a few old villages left, tucked amongst the New Town's high-rises, the sports centre and the racecourse, but they don't grow any rice.

As of now, in summer 1983, only three villages on Lantau still grow

rice. Six months ago there were four, but one dropped out this year. The total area under rice in Lantau is probably not more than one hectare. There may be a few more hectares in the New Territories.

This is why we're interested in the rice the Tsui brothers grow here in Tai Long Wan, for this is not hybrid rice, and it could be an original variety -- two varieties, in fact, one for the first crop and one for the second.

I asked Tsui Kam-fook about it, but he was rather vague: "We've always had it," he said, and changed the subject.

There are also other old crops to be found here. Seventy per cent of the US sweet potato crop is planted to one variety, but the Tai Long Wan villagers plant five varieties of sweet potato. The leaves are different shapes, the skins of the tubers are different colors, and the flesh ranges from white to white with red streaks to yellow to deep orange. There are also seasonal differences, though it's difficult to work them out because they all grow all year, given water. But each has a different optimum growing season, and between them they supply consecutive harvests throughout the year.

Peanuts, taros, spring onions, gourds and some of the cabbage crops all seem to be originals, and possibly some of the fruit varieties.

The future of these varieties is by no means secure. Tsui Kam-fook is seriously ill. His wife has seeded their rice nursery, the seeds have sprouted and are almost ready for transplanting, and the paddies are ploughed and flooded. But she is not young, and will not be able to manage the crop on her own if he doesn't recover.

When trouble has hit other families here, their first response has been to give up growing rice and sell their cattle, which they mainly keep for ploughing and harrowing the paddies. This could well be the fate of Kam-fook's rice paddies next year -- or even of this year's second crop.

His brother Kam-pui will continue growing rice, but he is also not well, and rice isn't very profitable: it takes a lot of labour, yields are not good, and the price is low.

Less than half an acre of land -- seven fields out of 130 -- has been prepared for rice this year. Last year's was about the same, but next year's could be much less. Or none at all.

The sweet potatoes are no more secure. The villagers don't value the sweet potatoes: they seem to grow them from force of habit as much as anything else. Their main use has traditionally been as pigfood and for insurance in hard times: they were the mainstay against famine during

the Japanese occupation of Lantau in World War 2. But there are no pigs here now, and the villagers no longer have to depend on their own produce for their survival.

It isn't only the old varieties that are threatened: the whole structure of farming here is on the point of collapse. Many of the villagers hardly bother to farm at all, and sometimes it seems those that do are only going through the motions for want of something better to do.

I once asked Kam-pui why he hadn't moved to the city when he had the chance 20 years ago, like a lot of the other villagers had done (they received a big government pay-off for land).

"Because I was bloody stupid," he said.

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Nutrient Starved Soils Lead To Nutrient Starved People

by Keith Addison

Published in acres, USA, June 1983, and Asian Business, February 1983

acres, USA

Asian Business

Malnutrition cut

Soon after this report was published, a bio-intensive organic gardening program was started in Negros Occidental, which cut the rate of malnutrition from 40% to 25% in only two years.

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Pollution

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THE basic wealth of an agricultural society is the soil. Viewed in that light, the Philippines is on the brink of a much worse form of bankruptcy than is generally realized.

Galloping soil impoverishment has all but exhausted the country's reserves of fertility, while current crop production presents a correspondingly dismal picture of soaring inputs and slumping yields affecting every sector.

The population clearly reflects the symptoms of spiralling decline in the agricultural base, with shocking child mortality and malnutrition rates and a proliferation of deficiency-related diseases like anaemia and goiter. Cancer surgeries do a brisk trade in every rural hamlet.

Many people do not have enough food. Those who do have enough suffer nonetheless, because the food itself no longer contains the nutrients essential for health -- the soil can no longer supply them.

Not enough is being done to reverse the trend, largely because of top-level refusal to admit there is a problem.

The official picture is a rosy one of brave advances made in the face of difficulties and setbacks which all originate abroad, such as declining foreign markets and the rising cost of imported fertilizers.

White hybrid rice, white

But snubbing the problem will not solve it. Confidential reports by foreign agronomists working in the country have predicted general crop failure within three years, and independent soil tests support this prediction.

Poisoned rice

Full story

Ipil-ipil, the 'magic tree'

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Young, poor and hungry

Full story

The NPK mentality at work

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Disposal problem

Full story

bread, yellow hybrid corn and a soft-drink -- a meal free of nutrition

"A crash program to refertilize the soil on a national scale, starting now, might succeed in turning it around in about five years," a western soils scientist said. That would leave two hungry years in between.

The country's urban elite, though they may pay lip service to the Malacanang Palace mythology of national well-being, are beginning to realize this, and the dread word famine is being whispered in exclusive business clubs and around society dinner tables.

How has this happened? Ignorance, negligence and basic misconceptions about the nature of soil fertility and the production of healthy crops (faults which are by no means confined to the Philippines or to Southeast Asia) have all played their part.

Very little is, in fact, understood about the complex interactions between living and dead matter in the soil that make plant growth possible. What is clear is that fertility has to be maintained: what a crop removes from the ground has to be replaced, or the soil becomes depleted. That may sound elementary but it is far from universal practise, and in the Philippines it has become downright rare.

Just how the crop's uptake of soil nutrients is best returned to the soil is a different question. Here nature, the supreme farmer, provides the best examples. Nature's best farming practises are to be found in forests, which can maintain themselves for thousands or, in the case of tropical rain forests, millions of years without decline. Several rules are immediately clear:

- Multicropping is the rule: nature never attempts monoculture.
- Nature's farming is mixed: crops are always raised in conjunction with livestock.
- The balance between growth and decay is strictly maintained: what grows dies, and in dying is returned to the soil.

Thus the forest floor beneath the leaves contains a layer of topsoil rich in organic matter, both vegetable and animal, slowly decomposing by agency of hosts of microorganisms into humus -- the essential plant food that provides a slow release of scores of nutrients necessary for healthy plant growth in the form and balance that suits plants best.

Organic failure is certain

Fertility is a process, largely intractable to quantitative

Starving animals

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Tai Long Wan
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measurement. A fertile soil is alive: one hectare of good topsoil contains about 150 metric tons of organic matter, of which about 22 metric tons are living matter such as bacteria, fungi and earthworms, while the rest is in various stages of decay.

The dynamic relationships between the various types of decaying matter to each other and to the microorganisms which digest them, and of these to each other, and of all these factors to the plant, are complex in the extreme and may possibly never be fully understood. But the system can be emulated.

The traditional Chinese farming system is one that has copied nature successfully. After 4,000 years there has been little decline in the fertility of China's topsoils and no decline in crop yields.

There is little monoculture in China: farmers long ago developed what remain one of the world's best multicropping and crop rotation systems, with one crop replacing what another takes out and the various crops protecting each other from pests and disease.

Crops and livestock are raised together, and growth and decay are balanced: all waste matter -- vegetable, animal and human -- is faithfully returned to the soil.

In the Philippines, that is not the case. Most cropland soil is virtually dead, the microorganisms killed by chemicals. There is a serious lack of organic matter.

Where good topsoil should contain 5% of organic matter, soil test results of typical Philippine rice, sugar and coconut lands in Luzon, Negros and Mindanao show organic content levels of 1.17%, 1.04%, 0.62%, 0.28%, 0.08%, and in some cases nothing at all.

This sugar farm is dead, the "crop" not even worth cutting. The previous crop wastes lie on the ground, still fresh and undecayed after a year

Year after year these have been monoculture farms growing just rice or sugar. There is little or no mixed cropping or crop rotation. There is also little or no livestock in evidence, except in concentrations largely divorced from the cropping systems.

The two essential components of the all-important humus content of a fertile soil are absent: the soil receives

Forbidden fruit

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No sugar

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Hong Kong and Southeast Asia
-- Journalist follows his nose

Nutrient Starved Soils Lead To Nutrient Starved People

Cecil Rajendra
A Third World Poet and His Works

Full story

little animal manure, and except for the discarded roots of harvested crops, little or no crop waste is returned to the soil as green manure. Hence the lack of organic matter.

The soil tests also showed dangerously low or nonexistent levels of many of the major elements required for plant nutrition.

The farmers' and the Ministry of Agriculture's answer to this is simplistic. The main cause of the problem is an over-reliance on chemical fertilizers; but the solution now offered to the impoverishment caused by this over-reliance is ever greater doses of the same medicine.

There is nothing intrinsically wrong with using chemical fertilizers, though some are better than others. The mistake lies in thinking that they provide the complete answer to fertility maintenance. They can be efficient when used in conjunction with organic fertilization such as compost, manure or recycled crop wastes; but while they can supplement it, they can never supplant humus in the soil -- and the source of humus is organic matter, not chemicals.

To grow at all, rice, sugar and other plants require six essential nutrients known as macro-elements: nitrogen (N), phosphorus (P), potassium (K), calcium, sulphur and magnesium. There are another 52 micro-elements, five or six of which are necessary to have anything like a decent yield and several more for the crop to be a nutritious one (in the case of rice). For a good crop, at least 20 of them should be readily available in the soil.

That is also simplistic, for it says nothing of the subtle synergistic effects of those elements in combination with each other upon plant growth and it ignores the complex nature of humus. But how much more simplistic is the attitude that the whole problem can be satisfactorily solved by replacing the crop's uptake solely with chemical fertilizers containing nitrates, phosphates and potash in various forms, strengths and combinations, and nothing else?

The NPK mentality

This attitude has been called "the NPK mentality". It is at the root of many of the world's current food problems. During the past 25 years it has gained a stranglehold on the Philippines, displacing traditional, more sustainable practises until it is now virtually the only attitude left.

On plantation lands such as the sugar estates, the previous practise

Leave the farmers alone
Book review of "Indigenous Agricultural Revolution -- Ecology and Food Production in West Africa", by Paul Richards

Full story

A timeless art
Some of the finest objects ever made

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Health hazards dog progress in electronics sector
The dark side of electronics -- what happens to the health of workers on the production line

Full story

Mo man tai ('No problem')
-- "Write whatever you like" -- a weekly column

of leaving fields fallow for one season in rotation so that the soil can regather some of its strength has been squeezed out by the falling economics of sugar production. Most sugar planters now rely solely on NPK fertilizers.

With crops such as rice, the so-called "Green Revolution" has brought high-yielding varieties which come in complete seed, NPK fertilizer and pesticide packages, displacing the old methods of organic fertilization. The result has been depleted soils and poor crops. Only in Baguio, whose market gardeners are expert organic farmers, is the picture different.

It can fairly be said that the authorities -- the Ministry of Agriculture, the Bureau of Soils (BoS), bodies such as the Philippines Sugar Commission (PhilSuCom) -- have little idea of the true condition of the country's croplands.

The Bureau of Soils laboratory at their provincial headquarters in Bacolod City, Negros Occidental, consists of a couple of porcelain sinks, some glass jars, thermometers and test tubes, a chemical balance, and a table supporting rows of small manila packets containing soil samples waiting for testing. The staff is two young men and a typist.

In charge is supervising soil technologist E.M. Gregorius, who is to be found at the Ministry of Agriculture headquarters a block away. He said the laboratory could handle up to 20 samples a day. Most farmers only sent one sample, which is tested for N, P and K and for pH -- the acid/alkaline level on which lime applications are based.

Tests for other macro-elements and for micro-elements such as iron or iodine were available on request from the regional laboratory in Ilo Ilo in Panay, he said, though there were very few requests for such tests.

The bureau, Gregorius said, produced fertilization recommendation maps for the province for N, P and K plus lime. There was no detailed map of soil types apart from an old map dated 1948 hanging on the laboratory wall, showing broad areas color-coded for soil types of the whole island of Negros.

The inadequacy of this becomes clear when it is compared to the work accomplished on a single 140-hectare Negros sugar farm by a foreign soils scientist retained by the planter because neither the BoS nor PhilSuCom had been able to allay his suspicions that all was not well with his soil.

Swag bag
Death of a Toyota

Full story

Zebra Crossing
-- On the wrong side of South Africa's racial divide.

Kwela Jake
Sold into slavery
Mamelodi
Finding Tom Hark
Return of the Big Voice
Brother Jake

Curriculum Vitae

Thorough tests had found 16 different soil types on this one farm with more than 90 soil profiles from field to field. Specific fertilization programs based on these results, including a certain amount of organic recycling, had not only improved the yields, but had saved the farmer P150,000 in fertilizer inputs for the first year.

In complying with the official recommendations, he had been heaping expensive potash on already potash-rich soils year after year while his fields were starving for want of several cheap micro-nutrients and organic matter.

At the national headquarters of the BoS in Manila, German Jonas, head of the soils analysis section, admitted that the BoS could not provide such a field-by-field analysis for NPK only, and certainly not for micro-elements. The Bacolod City laboratory "certainly needed strengthening", he said, but his own laboratory was well-equipped to conduct micro-element tests.

Could his laboratory test for the availability of the micro-element iodine in the soil? He had recently received several requests for iodine tests, though he did not know why people wanted them all of a sudden. But he could not find a method to test for iodine and was searching for one.

Disbelief

Soils scientists questioned in Hong Kong expressed disbelief at this: the iodine test, they said, was a chemical test basic to soils science and was detailed in any text book on the subject.

The reason that Jonas had been receiving requests for iodine tests is that the Philippines is now rife with goiter, an iodine-deficiency disease, because the exhausted cropsoils can no longer supply it to the food they eat. That the iodine test is so far beyond the horizons of the BoS is an example of the NPK mentality at work.

Following a global study last year, a Food and Agriculture Organization (FAO) soils bulletin, which the BoS must have received, pointed out several soil nutrient deficiencies in the Philippines and warned of an accelerated exhaustion of micro-elements in soils and of the possible geomedical consequences for humans.

In Bacolod City, opposite the desk of soils technologist Gregorius, sits S. Parohinog, who is in charge of Ministry of Agriculture extension officers serving rice farmers in the province.

His officers, he said, recommend to all farmers, regardless of the condition of their soils, that they apply 80 kilograms N, 30 kilograms P and 30 kilograms K for the first crop of rice and 100 kilograms N, 30 kilograms P and 30 kilograms K for the second crop.

But what about Gregorius' fertilization maps? He brushed the question aside: "It doesn't matter much," he said. "Most of the small farmers can only afford about half the recommended input anyway." What about organic input? "We have a new plan, in the irrigated areas only, promoting the use of azolla as an organic fertilizer," he said.

Azolla, a pond weed, provides the soil with organic matter rich in nitrogen, cutting by half the nitrate component in fertilization programs. It also helps to keep weeds down, cutting herbicide costs, while increasing the yield considerably -- a good example of what organic fertilization can accomplish.

This is not new: the nitrogen-fixing properties of the unique azolla/blue-green algae symbiosis have been in widespread use in the ricelands of China, Korea and Vietnam for at least 1,500 years.

In the Philippines, some 5,000 hectares of irrigated lands now use azolla, but the vast majority of irrigated farms and all the rain-fed and upland farms still rely on usually inadequate amounts of NPK fertilizers.

Growth medium eroded

Another serious aspect of the soil problem is the rate of erosion. Huge amounts of topsoil are washed away every time it rains, and the loss is accelerated by the breakdown of soil structure caused by the mechanisms of fertility depletion.

The situation is greatly worsened by the rate of deforestation, with millions of hectares of forest land denuded annually, mainly by illegal loggers and kaingeros (slash-and-burn farmers).

As the trees and ground cover are lost, the exposed soil washes away, strangling irrigation systems and silting up rivers, which then flood croplands, destroying crops and washing away yet more topsoil.

In some areas, irrigation systems are so badly silted that it has been

suggested that underground water sources be utilized instead.

The official answer to these problems centres on the intensive promotion of ipil-ipil cultivation. A fast-growing legume, "fixing" nitrogen from the atmosphere and making it available in the soil for plant growth, ipil-ipil was presented as a wholly useful tree.

It would solve the reforestation problems, reverse the spread of erosion, refertilize the soil with its nitrogen-fixing capabilities, provide millions of metric tons of saleable wood for use as fuel and lumber, and solve the problems of the landless kaingeros who were encouraged to cultivate it.

But the scheme has failed. Experience has shown ipil-ipil to be far from the grow-anywhere tree it was supposed to be. It will not thrive on the poor soils and eroded upland slopes it was intended for and can even contribute to further soil depletion, while timber yields have seldom equalled targets.

Victorias Milling Corporation in Negros Occidental, which had switched to dendrothermal (woodburning) technology to save fuel costs, was forced to spend thousands of pesos per hectare last year on revitalizing its ipil-ipil plantations or face fuel shortages.

Given the same problems, kaingeros continue to slash and burn, causing further erosion.

Far from being the ideal restorer of marginal lands and ex-forests, ipil-ipil, like other crops, has been found to thrive best on good agricultural land, which it certainly doesn't deserve. It can be ruled out of the soil fertility question.

Much of the damage could be repaired and large amounts of money saved if locally available organic wastes could be recycled to the soil.

Large-scale waste recycling could effect huge savings through import substitution of expensive chemical fertilizers. Hundreds of millions of pesos could be saved this way, which could be applied to the costs of refertilization.

Waste recycling presents problems in the Philippines. Application of potash-rich rice straw, the composting of sugarcane tops instead of burning them, or the collection and application of animal manures are matters of education.

But returning the mountains of rice husks piled outside the rice mills

to the farms in the form of usable, silica-rich ash presents considerable logistical problems, which also apply to wastes such as coconut husks -- a rich source of potash -- and distillery slops, which are rich in nitrates.

Wasted garbage

The real dividends, however, and also the greatest difficulties, lie in the cities. The organic-rich garbage of Manila could supply the starving soils with about 300,000 metric tons of compost a year, and that of the other cities, towns and villages could add a further 2,500,000 metric tons.

In a special inquiry last year, Manila Vice-Governor Ismael A. Mathay, Jr., found that the city's Environmental Sanitation Centre, which is responsible for Manila's garbage collection, was riddled with graft and incompetence.

Despite its staff of 12,000 and its massive funding of P200 million a year (almost half the city's total budget), a huge proportion of the garbage was not even being collected but mouldered instead in the streets, constituting a major health hazard.

What garbage is collected is another problem. Two Japanese composting plants are to be built, which will be useful; but enormous mounds of trash on dumpsites still constitute a disposal problem not solved by a P0.8 million World Bank-funded study which has recommended sanitary landfill -- though that is impossible because of Manila's high water table.

The obvious answer is to link the disposal problem to the needs of the soil. But are the city authorities capable of accomplishing this? Past performance does not imbue confidence. More likely the city will continue to drown in its wastes while the the land continues to starve.

Crop pests

Lack of nutrients is not the only threat to the crops. Malnourished plants, like malnourished people, are prone to disease, and crops are now extremely vulnerable -- especially the rice crop.

To see crop pests in perspective, one should return to the example of the forest, where every form of plant and animal pest and disease is found, and yet fauna and flora populations are maintained at a peak of health and virility. Here disease and pests play a role similar to

that of the predator.

As an example, research has found that Canadian wolf packs ensure that only the fittest caribou survive; without the wolves, the health and quality of the herds soon decline.

Disease and pests are thus promoters of health -- nature's mechanism for removing poor specimens and returning them to the soil.

Crops in the Philippines are under heavy attack by a wide variety of pests and diseases; the favoured solution is, of course, pesticides.

But apart from their side-effects (unacceptable environmental damage, plus some 375,000 reported poisonings a year in the Third World), pesticides just don't work well.

Highly adaptive pests quickly develop resistance to them, outpacing the use of ever higher dosages and the introduction of new poisons. It is a losing game.

Like the NPK mentality, of which it is an offshoot, the poison approach is simplistic. In combination, the two misconceptions can be devastating.

For instance, sugar and rice are both mycorrhizal plants; unlike legumes, they cannot fix nitrogen from the atmosphere and must gain their nutrition from the soil. That is facilitated by a symbiotic association with mycorrhiza soil fungi, which digest humus in the soil and are then in turn digested by the plant roots.

It has been shown that chemical fertilizers either destroy the vital fungi or render them indigestible by the plant, whose feeding is then impaired.

Those same fungi have been found to be inimical to nematodes, microscopic parasites that feed on roots, several varieties of which infest Philippine sugarcane crops, to the detriment of the plant's health and its yield.

Recommended treatment is the application of carbofuradan insecticide, setting off the futile chain of resistance and higher dosages and effectively murdering what vestiges of mycorrhiza might have survived the chemical fertilizers, further weakening the plant.

A South Negros sugar planter, put off chemicals by the rising costs of inputs and slumping yields as well as by the fact that his

manager's children had been poisoned by carbofuradan, applied only organic fertilizer to two of his eight nematode-infested sugar fields and the usual chemicals to the other six.

Without the use of any pesticides, the nematodes disappeared from the organically-fed fields as the mycorrhiza fungi recovered. The plants, freed from nematodes and with their main food source restored, delivered a much improved yield. Costs were reduced and production increased.

Green Revolution

Traditional rice culture, using organic fertilizers and a wide variety of native strains -- which over the centuries had developed immunities to local pests (in other words, they had passed nature's fitness test) -- has been practically wiped out by the new technology of the Green Revolution, and the hardy and nutritious native strains are now hard to find or lost.

The response to the introduction of the new dwarf hybrid strains, with their high yields (and low nutritional value) and their reliance on an artificial environment of chemical fertilizers and pesticides, was what the International Rice Research Institute (IRRI) terms "an unexpected buildup" of pests and diseases which soon became resistant to the pesticides.

The IRRI scientists responded by finding stronger pesticides and developing ever more new strains with built-in resistance to the pests.

That led to what is called mono-gene domination of the rice crop. Instead of the variety of native strains with their various immunities, the crop came to depend on the survival of one strain only with its test-tube resistance.

In 1973-74 the Philippines rice crop was almost wiped out by tungro, a virus disease carried by the brown plant-hopper -- an insect pest which keeps developing new biotypes resistant to the latest crop strain's immunity to it. In 1975 Indonesian farmers lost half a million acres of rice to damage caused by the rice hopper.

IRRI hastily produced new resistant strains, but this resistance only lasts for a couple of years before the strain has to be replaced. Rice is now threatened by 23 pests and diseases.

In the long run, who will win this extraordinary duel: nature's troops

or the IRRI scientists? Is it sensible to put an entire nation's eggs in one basket like this?

It has been shown that, given good soil, traditional varieties can equal the new hybrids in yield while far surpassing them in both disease resistance and nutritional value, without the need for artificial fertilizers and pesticides. Again, the key is the soil.

It has also been shown that the high yields attained with the hybrids on the experimental stations cannot be reproduced even on rich farms, and most farms are anything but rich.

Some of the larger mechanized, irrigated farms achieve yields of up to 6,000 kilograms per hectare. In fact, this is a poor harvest and barely economical; it compares poorly with the yields of up to 30,000 kilograms per hectare not uncommon in Japan.

Most farms, however, can produce only 1,500 to 4,000 kilograms per hectare, on which they can hardly feed themselves. Despite the official line from Manila, they do not have access to the credit and assistance provided only to richer farmers. It simply does not reach them. They cannot afford the necessary inputs.

The country's millions of landless peasants and seasonal labourers are far worse off. Many are the rice terraces hewn with incredible labour from upland slopes and tragically abandoned after only a year when the ground failed to yield a crop at all -- meaning the end for that family.

Had they used native rice, they would have got some crop at least. But hybrid seeds are now virtually the only seeds available and they will not grow without the expensive inputs that these people have no access to.

While the benefits of the new technology have meant that the Philippines has, since 1977, turned from importing rice to producing exportable surpluses (200,000 metric tons last year), that does not mean, as claimed by Manila, that the country is now self-sufficient in rice. It simply indicates an inequitable distribution of resources, as is confirmed by soaring malnutrition rates.

With the country's high population growth, there will be between 85 million and 100 million people to feed by the year 2000; and with lands devoted to export crops like sugar and coconut oil remaining unavailable for food cultivation, despite their tumbling yields and failing markets, all those mouths will have to be supplied by the same land which is failing to feed the current population.

There is only one way to achieve the required production increases on those lands -- not by developing new hybrid strains that will grow in deficient soils, which is the method adopted by IRRI, but by attending to the soil itself.

See also:
Seeds of the world -- Journey to Forever
Treasure in a bowl of porridge

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Pollution

With the slump in exports and prices, excess sugar is being diverted to alcogas production to substitute for petroleum fuel imports. The production of one litre of alcohol produces 10 to 12 litres of distillery slops which -- when applied to sugar fields and added to irrigation water -- have been shown to increase yields. The slops can also be cheaply concentrated into an effective and saleable nitrogen-rich organic fertilizer. But Victorias Milling Corporation's alcogas plant at Caren in North Negros prefers to tip its slops into this river, killing fish in downstream fish farms and polluting a wide area with foul and noxious nitrate fumes.

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Poisoned rice

FMC's Furadan kills insects, but it doesn't stop them from coming back because they develop a resistance to it. It can also kill animals and people. In 1978 it was banned in the Philippines for use on the edible parts of plants and banned altogether for use on rice. But it is still widely used on rice crops, as this August 1982 photograph indicates.

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Ipil-ipil, the 'magic tree'

This is a Bureau of Forest Development nursery. A research team assessing the performance of an ipil-ipil scheme was told by the Bureau's Manila headquarters, and again by the provincial office, that 400 hectares were under ipil-ipil cultivation in the scheme. The mayor's office in the local town told them the actual area was 200 hectares, and the local forestry official amended this to 100. They went to see for themselves and found rather less than 50 hectares of ipil-ipil trees, with the trees growing at about one-fifth of the targeted rate -- amounting to only 2.5% of the production counted on in Manila.

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Young, poor and hungry

This underweight, swollen-bellied child seldom smiles; but he is luckier than others. "The big growth industry around here is the manufacture of little coffins," said a despondent rural health worker. According to the Nutrition Centre of the Philippines, half of all deaths recorded annually are of children under five, and half of these deaths are directly related to malnutrition. Of the country's 9 million children less than six years old, less than a third have normal growth rates and more than a third are actively malnourished -- suffering from serious diet deficiencies. Of children aged from one to six, 75% are anaemic (suffering from lack of iron) and 75% are deficient in vitamin A (which leads to eye disease and blindness). More than a third of school-aged children are malnourished. Regional studies of pregnant and lactating women have found that 21% are anaemic and 41% suffer from goiter (caused by lack of iodine.)

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The NPK mentality at work

Ricefields are increasingly being given over to the production of yellow hybrid corn such as this Hycorn 9 recommended by the

Maisagana grain program and supported by the KKK livelihood program. Posters and leaflets distributed by the Ministry of Agriculture recommend, regardless of soil type or condition, the application at planting of six bags of 14-14-14 per hectare, and, 25 to 30 days after planting, of a side-dressing of three bags of urea or five bags of ammonium sulphate per hectare -- all NPK fertilizers -- as well as four separate applications of various insecticides and weed killers. According to an American nutritionist, hybrid corn lacking the nutrition-rich germ is as nutritional as tissue paper. However, it is not meant for human consumption, but for feeding meat animals (which are meant for human consumption). But even pigs are reported to be reluctant to eat it unless it is supplemented with molasses.

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Barefoot crop-spraying: from the Maisagana Program leaflet, Basic Steps to Successful Hybrid Corn Culture

Disposal problem

Mountains of rice hull outside every rice mill constitute a disposal problem, despite schemes to use it for fuel or as a base for particle board manufacture or even as an animal feed, though it lacks protein. Rive hull is 83% silica and rice beeds silica to grow, but little rice hull is returned to the soil in the Philippines.

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Starving animals

These products of a national cattle dispersal scheme sponsored by First Lady Imelda Marcos' KKK livelihood and development program were received in this condition from a Bureau of Animal Industries stock compound. The BAI 'had no budget to feed them'. The farmer whose livelihood they were intended to develop lacked pasture and was feeding them on protein-deficient sugarcane tops.

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'Sweat of the brow' fertilizer

Manuel Garcia is an uplands smallholder who prefers to follow the farming methods of his forefathers and has prospered as a result.

Ploughing deep

"There was nothing when I came here 20 years ago. I had nothing, not even a bolo (machete), just a small knife. Now I have a good farm and even some money in the bank.

"Everything grows well here. I have all kinds of fruit trees, rice, corn, vegetables, some coffee and some sugar, chickens and ducks and some pigs. Yet other farmers did not want this land. They said nothing would grow on it.

"The trouble is that they are lazy. They do not want to plough deep, it is too much trouble for them. But if you don't plough deep, the rain washes away the topsoil. If you plough deep enough, it soaks through the topsoil into the subsoil.

"When I harvest my corn, I do it myself. I won't let anyone help me. I take the corncobs and then I chop the rest of the plant, the stalks and the leaves into small lengths so I can plough it back into the soil with some manure.

"The waste from the plants is just as good as chemical fertilizer and it costs nothing. It is the same with the other crops. I put the waste back or I make compost with it.

"But my neighbours don't do this. They burn the waste instead. It is easier that way; they will not plough it in because that makes ploughing more difficult. They see that my crop is better and that I save money, but they are too lazy to follow me.

"I don't need insecticides here. I don't spend money on them. Only a few plants are attacked by insects. It is no problem. I grow native rice. It is better to eat than the new rice, and cheaper to grow. The yield is good, and I can use the seeds for the next crop.

"With the new rice you cannot use the seeds again; you must buy new seeds each time. And the insects like the new rice. You need to use insecticides. Most people use the new rice now. The native rice is becoming hard to find. But they cannot afford the fertilizers and the insecticides for them, so their yields are bad.

"They cannot get crop loans. It is said that they can get loans, but you can only get a loan if you have money. Most of these people have no money -- they are all in debt.

"There are about a thousand families here, but only about 70 own their land. If you don't own the land, you cannot get a loan. Even those who own their land are struggling. Many people are hungry; many are sick, but there is no clinic here."

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Seeds of the world

Bio-intensive gardening cuts malnutrition in the Philippines

In response to the 1984 economic crisis in the Philippines, the International Institute for Rural Reconstruction (IIRR) developed a bio-intensive gardening program in the Province of Negros Occidental to increase food availability for Negros islanders.

Two years after bio-intensive gardening was introduced in 1986, the rate of malnutrition had dropped from 40% to 25%.

Bio-intensive gardening aims to rebuild and maintain soil fertility through nutrient cycling, diversified cropping and deep-bed preparation on small-scale plots (200-500 sq. feet). Bio-intensive gardens contain a diverse range of indigenous crops which minimizes the opportunities for pest outbreaks and preserves indigenous seed varieties. Families with these gardens can save cash that they would normally spend on food or non-food essentials for the family. Bio-intensive gardens may also produce enough food for families to sell the surplus and still meet their own nutritional needs.

The implementation of bio-intensive gardening (BIG) in Negros Occidental relied on four levels of training:

- IIRR trained 150 indigenous garden promoters in the bio-intensive technique.
- The promoters trained their neighbors.
- IIRR provided training to other local agencies interested in bio-intensive gardening.
- IIRR collaborated with the Department of Education, Culture and Sports to train 1,120 school teachers in BIG techniques. The teachers then set up demonstration gardens in 400 schools.

As a training aid for extensionists, IIRR developed a package of educational materials containing slides, flash cards and brochures. The IIRR training materials emphasize adaptation of the gardening technology to the ecological zone and to cultural and economic conditions, rather than adoption of a set of defined practises. The materials outline a basic approach, yet describe three tillage options for garden beds: double-dig, deep dug and

No seeds, no food
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Children's poetry

raised bed. The training packet also contains a description of the bio-intensive method and its potential for sustainability.

The **"Bio-Intensive Approach to Small-Scale Household Food Production"** training manual is free.

-- From **"How to Garden Bio-Intensively"**, International Ag-Sieve, Volume VI, Number 1, 1993 (Urban Gardens), the Rodale Institute. Back issues are available for US$3 per issue, $1 each for more than six issues, the whole set of 36 issues for $35. Now published in book form, includes articles on green manure, agro-forestry, irrigation, biological pest control, erosion and more -- 26 assorted articles, from 1989 to 1995. From Rodale Institute Bookstore: http://rodaleinstitute.org/bookstore/products/farm_books/9.html

International Institute of Rural Reconstruction (IIRR)
http://www.iirr.org/

Bio-intensive gardening: see **Ecology Action**
http://www.growbiointensive.org/

"**How To Grow More Vegetables** -- than you ever thought possible on less land than you can imagine" by John Jeavons, director, Ecology Action

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Cecil Rajendra: A Third World Poet and His Works

by Keith Addison

Published in South China Morning Post, September 19, 1982, and Bangkok Post, December 5, 1982

Bangkok Post
LITERARY PAGE EDITED BY KANJANA SPINDLER
South China Morning Post

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Strength underpinned with skill

by Keith Addison
Published in Far Eastern Economic Review, June 23 1983, and Sunday Star, Malaysia, June 26 1983
Full story

Books by Cecil Rajendra

Full list

Malaysian poet Cecil Rajendra's poems turn up in the most odd places: at a church-sponsored conference on the evils of tourism, in a Black South African liberation movement's newsletter, in a mass-circulation Japanese daily paper, in a Filipino law professor's human rights lectures, in a geography textbook for British schoolchildren, in a Bengali magazine, in a book about militarism, in a Time magazine cover story, in a Penang taxi driver's glove compartment -- but seldom in literary journals.

"My poems tend to be more a part of Third World studies than literature studies," Rajendra says. "They find themselves in all sorts of places, and I am most pleased about it."

Rajendra: "Almost every aspect of our lives here is circumscribed by some piece of legislation or other."
-- Photograph Christine Thery

He is genuinely not interested in literary acclaim, nor abuse, though he has received plenty of both. Rajendra judges his work strictly in terms of its effectiveness in awakening people to the burning social issues that afflict Malaysia and the Third World generally -- oppression, injustice and exploitation, corruption and greed, want, hunger and poverty, ecological ruin.

His poetry is part of a total commitment. A lawyer by profession, he handles mainly pro bono cases where a principle of justice is involved, defending factory workers who find themselves on the wrong side of the country's highly oppressive labour laws, taking drugs cases involving youths from fishing villages shattered by ill-considered tourism projects, representing peasants denied justice because once in the witness box

The Animal & Insect Act

Finally, in order to ensure
absolute national security
they passed the Animal &
Insect
Emergency Control &
Discipline
Act.

Under this new Act,
buffaloes
cows and goats were
prohibited
from grazing in herds of
more than three. Neither
could
birds flock, nor bees swarm
.....
This constituted unlawful
assembly.

As they had not obtained
prior
planning permission,
mud-wasps
and swallows were issued
with
summary Notices to Quit.
Their
homes were declared
subversive
extensions to private
property.

Monkeys and mynahs
were warned to stop
relaying their noisy
morning orisons until an
official
Broadcasting Licence was
issued
by the appropriate Ministry.
Unmonitored publications &
broadcasts posed the gravest
threats in times of a National

or dock they are struck dumb by the augustness of the proceedings, the belittling effect of the legal stage props, the theatrical pomposity of the official fancy dress.

Though he wins cases and obtains some measure of justice, he sees law and justice as two different things in Malaysia: "There's no question of practising law here, it's almost a farce. We hardly touch the real issues. I often have to suspend my sense of reality when I enter court."

Rajendra the lawyer: "I often have to suspend my sense of reality when I enter court." *-- Photograph Christine Thery*

After a succession of setbacks, he has set up a free legal advice centre in a depressed rural area in Penang, serving needy people who would normally have no access to legal representation.

He has also considered giving up law altogether and taking up writing full-time, perhaps as a journalist at The Star, a national daily tabloid which publishes his controversial weekly column on the arts scene, as well as many of his poems.

"The Star has a readership of about 300,000," he said. "That's fantastic for a poet. It is one of the few papers here that is prepared to take a few risks. I've managed to have a lot of poems published through them that were very critical of some of the things that go on here, and the feedback I've been getting has been most encouraging.

"I wrote a poem called 'The Animal & Insect Act' about some of our repressive laws -- almost every aspect of our life here is circumscribed by some piece of legislation or other.

"People told me I'd never be able to publish it in this country, it was much too explosive, and at first it was circulated on roneoed sheets. Then I talked to the editor of The Star about the poem. He agreed to publish it, and I was amazed at the impact it had.

"For instance, one day I caught a taxi to Georgetown from my home on the outskirts of the city. We set off, and the driver started chatting to me. He asked if I was Cecil Rajendra. I said I was, and he said, 'I liked that poem that you wrote very much.'

Emergency.

Similarly, woodpeckers had to stop tapping their morse-code messages from coconut tree-top to chempaka tree. All messages were subject to a thorough pre-scrutiny by the relevant authorities.

Java sparrows were arrested in
droves for
rumour-mongering.
Cats (suspected of
conspiracy)
had to be indoors by 9
o'clock
Cicadas and crickets
received
notification to turn their
amp-
lifiers down. Ducks could
not
quack nor turkeys gobble
during
restricted hours. Need I say,
all dogs -- alsatians,
dachshunds,
terriers, pointers and even
little chihuahuas -- were
muzzled.

In the interests of security penguins and zebras were ordered to discard their non-regulation uniforms. The deer had to surrender their dangerous antlers. Tigers and all carnivores with retracted claws were sent directly to prison for concealing lethal weapons.

And by virtue of Article Four, paragraph 2(b)

"And he opened his glove compartment and took out a cutting of 'Animal & Insect Act' from The Star, saying, 'It's about time people spoke up about these things.'

"I was astonished -- he was a semi-literate guy, a taxi driver, how remote poetry must be from him. Yet he cut it out and kept it in his glove compartment. I was more flattered by this than by anything else. You would never get such a response in Europe. I lived in London for 13 years, and I regularly go back there; my readings there draw a lot of attention, but in terms of the real, immediate effect you can have, this place is far more direct."

"Animal & Insect Act" is one of Rajendra's most interesting poems. He followed up its publication in The Star by including it in "Refugees & Other Despairs", his fifth poetry collection, published in Singapore by Choice Books.

It has since travelled far: it was first heard in the US when Filipino law lecturer Dr Cesar Espiritu read it at a human rights seminar in Washington; he now uses it to illustrate all his human rights lectures, and the poem has since been published in the US, as well as in West Germany, Spain, South Africa and Japan, where it was included in a book on militarism in Southeast Asia entitled "People Against Domination."

Rajendra read it at a poetry recital during the Third World Book Fair held in London in April and was invited to read it on the BBC, which he did soon afterwards.

Echo from the past

The poem has an almost weird historical correspondence of which Rajendra himself was unaware. His angry ridiculing of modern security laws by applying them to animals is a strange echo of a similar anger finding the same expression, by a Malay social commentator writing 150 years ago.

Abdullah bin Abdul Kadir Munsi, research assistant of the famous Sir Stamford Raffles of Singapore, was appalled to learn that in the Malay state of Trengganu people were forbidden to use an umbrella, wear shoes or dress in yellow in the vicinity of the ruler's palace.

"Why aren't the birds prohibited from flying over the palace, or the mosquitoes prohibited from sucking the royal blood, or the lice from setting on the royal pillow or elephants from trumpeting in front of the palace?" he demanded, while real evils such as drug-taking,

sub-Subsection sixteen,
under no circumstances
were elephants allowed
to break wind between
the hours of six and six.
Their farts could easily
be interpreted as gunshot.
Might spark off a riot .....

A month after the Act
was properly gazetted
the birds and insects
started migrating south
the animals went north
and an eerie silence
handcuffed the forests.

There was now Total
Security.

-- Cecil Rajendra, Refugees & Other Despairs, 1980

Hothouse Anachronisms

"Slash and Burn Vandals" they
branded us
in treatise, journal, book
and exegesis.
And yes, we confess we
were guilty
of felling trees to meet our
daily needs:
fuel to simmer our gruel,
on cold nights
firewood to keep us warm. . .
.

But vandals
we never were, we never
took
any more
than absolute essentials.
Never!
Yet, "Slash and Burn
Vandals" they branded us

disease, poverty, ignorance and squalor were ignored.

This mirror-image from the past is significant because, though Rajendra has deep roots in Malaysia, he is often accused of being an expatriate at heart by the academics and formalists of the local literary establishment, who tend to see the social commitment in his writing as artistically gross, a pollution of literature.

"Dynamic" was how a reviewer of Britain's Times Literary Supplement judged Rajendra's work. "The whole experience was a complete, if unconscious, refutation of the academic and disengaged approach."

Certainly his inspiration has been more international than local: his technique has been influenced by the directness of the Japanese haiku poets, his thinking by such men as Amilcar Cabral, Pablo Neruda, Franz Fanon, Walter Rodney, Martin Luther King, Malcolm X, Wilfred Owen, Dennis Brutus.

He is a Third World poet and his work finds relevance wherever men are poor and oppressed, exploited and robbed of their heritage. But it is with Malaysia that he is chiefly concerned, and about Malaysia for Malaysians that he writes.

"Faults in another / that would not matter / in our loved ones / assume / cataclysmic proportions / and if i did not care / i would not dare / chart / your many imperfections" he writes in "To my country".

But his Malaysian critics, both literary and political, do not see it that way, and he has been subjected to considerable pressure. So have the editors of The Star, and the publishers of "Refugees & Other Despairs", who responded by quietly withdrawing the book from circulation. Rajendra now plans to have it reprinted elsewhere.

**"Faults in another / that would not matter /
in our loved ones / assume / cataclysmic proportions /
and if i did not care / i would not dare /
chart / your many imperfections"**

He has found the wide relevance of his work useful as well as gratifying. He claims that Heinemann (Asia), who published "Bones & Feathers", his fourth poetry collection, would never have accepted some of the poems in the book had he not been deliberately misleading about their origins.

in treatise
after treatise, book, journal,
exegesis. . . .
the well-intentioned
environmentalists in the
metropolis.

Never once questioning the
hectare upon hectare
of our forests filched to feed
those voracious presses
that churned out magazines,
journals, books, treatises,
papers and exegeses that
condemned us
as savages--
unthinking, unfeeling "Slash
& Burn Vandals."

Cecil Rajendra

Poetry from The Literary Review: An International Journal of Contemporary Writing

http://www.webdelsol.com/tlr/tlrsu-cr.htm

"The Political Prisoner", dedicated to Nelson Mandela, jailed leader of South Africa's African National Congress, "The Fan", a chilling poem about an interrogation, dedicated to exiled South African activist and poet Dennis Brutus, one of Rajendra's early mentors, and "Salisbury -- City of Night", with its "armies of sleepwalkers", were in fact all written about Asia.

Conversely, poems written about other countries have been taken to refer to Malaysia.

Fishing off Tanjung Bunga Beach in Penang...

"When the tourists flew in", also from "Bones & Feathers", was written after a visit to Trinidad, and also partly about Haiti, where shanty towns were preserved as tourist attractions -- "chic eyesores", as the poem has it.

Yet the poem fits Malaysia almost perfectly, and especially Penang, where strips of beach hotels have displaced and disrupted fishing villages (including the one Rajendra was born and raised in); fishermen have indeed become waiters, there is a rash of escort agencies where before there were none; beaches are reserved for the exclusive use of hotel guests, and recently the residents of a rural village were outraged when tourist buses began arriving, bringing hordes of foreigners to gape at them.

... But now the beach is cut off from the fishing village by a new road.

This is perhaps Rajendra's most widely travelled poem. It was originally published in the Caribbean, and, apart from in "Bones & Feathers", it has since been published in Japan, the Philippines, Bangladesh and several other Third World countries.

Rajendra read it at a conference on tourism held in Manila at the end of 1980, where it was picked up by a regional news weekly and a travel trade journal, which used it to illustrate a report on how tourism can disrupt host societies. From there it was picked up again by Time magazine and published as part of a cover story on the Asian tourism boom, and with this, Rajendra found he had finally won the approval of his family.

Stories by Keith Addison

Tai Long Wan
-- Tales from a vanishing village

Introduction

Full story

Tea money

Full story

Forbidden fruit

Full story

No sugar

Full story

Treasure in a bowl of porridge

Full story

Hong Kong and Southeast Asia
-- Journalist follows his nose

Nutrient Starved Soils Lead To Nutrient Starved People

Full story

Cecil Rajendra
A Third World Poet and His Works

"I couldn't care less about an establishment journal like Time magazine," he said. "But my family was really proud of me. They'd never taken my writing seriously before."

Now they are more willing to consider his point of view, though his mother still wishes he would stop courting disaster with his foolhardy criticism of the rich and powerful.

"This time you've gone too far," she tells him each time a new controversy blows up, usually as a result of his columns in The Star.

"I try to explore the real values of Asian society, the cultural and spiritual values, not just the material values, which is the way the whole development process here is going," says Rajendra.

Cultural corruption

"My particular concern in writing these articles for The Star is culture, its role in society, how one can use culture to make people more conscious. Local artists have no confidence in their own culture. We take promising young people who produce work that is relevant and in context with the society they're living in, and send them overseas to study.

They come back corrupted, aping Western styles of 20 years ago. Our writers and poets are obsessed with empty form and the lofty ideals of 'art for art's sake', to the total exclusion of social relevance."

"The only alternative is silence, which is no alternative at all."
-- Photograph Christine Thery

Social relevance is his constant theme, and it has made him plenty of enemies. Though pertinent, his scathing attacks on the artistic and literary establishment have not exactly helped to placate them. Late last year, establishment resentment came to a head when he wrote a stinging reply in The Star to an extraordinary criticism of his work by Ooi Boo Eng, Professor of English at the University of Malaya. Rajendra, Ooi has written, was not a "true artist".

"The man has talent, which he has so far squandered. He isn't anywhere near being the poet he could have been had he been as

Leave the farmers alone
Book review of "Indigenous Agricultural Revolution -- Ecology and Food Production in West Africa", by Paul Richards

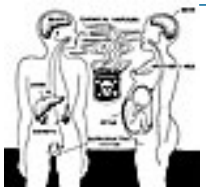
Full story

A timeless art
Some of the finest objects ever made

Full story

Health hazards dog progress in electronics sector
The dark side of electronics -- what happens to the health of workers on the production line

Full story



Mo man tai ('No problem')
-- "Write whatever you like"
-- a weekly column

consistently exercised by the ideal of poetry as agonizing if also joyous creation and arduous or even fastidious craft as much as he has been concerned with poetry as 'sincere', 'committed' statement in the cause of social and humanitarian issues."

"Ever tried stopping a tank with a neatly crafted stanza?" Rajendra demanded. "Or filling a child's belly with an over-ripe metaphor?"

He was hardly prepared for the widespread outrage this drew. He did receive support, but it was all but swamped by a tsunami of abuse and vituperation.

"Some of the letters really shocked me," he said. "A couple of them were definitely actionable, and some were from people I had thought were my friends."

He gave as good as he got in the following weeks as the controversy raged, but he was not sorry when the Asian PEN Conference held in Manila in December provided an escape.

"It started to erode my confidence," he admitted. "It was a great relief to be with people in Manila who see things the same way I do, writers who are committed to the same things."

Yet the conference wasn't much better.

"The theme was supposed to be 'Literature and Social Justice', but there were a lot of people there who took no notice of that: it kept degenerating into a sort of marketing seminar on the difficulties of getting your book published."

Writer's duty

Rajendra's address, "The Higher Duty of a Writer in a Developing Society", sparked off another storm: In an Asia ravaged by war, famine, disease, malnutrition, military repression, economic exploitation and ecological ruin he said it was indefensible not to take sides, not to be concerned with social justice and human rights.

"It becomes no longer a matter of choice, but the moral obligation and bounden duty of every responsible writer to bear witness to the times he lives in and to put his life and his work at the service of humanity."

His speech, brief and to the point, was widely reported in the Philippines press and elsewhere in the region, but virtually ignored

Swag bag
Death of a Toyota

Full story

Zebra Crossing
-- On the wrong side of South Africa's racial divide.

Kwela Jake
Sold into slavery
Mamelodi
Finding Tom Hark
Return of the Big Voice
Brother Jake

Curriculum Vitae

in Malaysia.

At the conference the debate raged to and fro, ending with a points victory for Rajendra and other committed writers like Mochtar Lubis, the award-winning Indonesian journalist, who delivered a powerful keynote address on injustice, and constantly strove to steer the erratic and confused discussion back onto its theme.

For social commitment does not come easily to East Asian writers. There is virtually no tradition of criticism in their countries, no real debate between rulers and ruled, no middle ground between meek acceptance and outright rebellion. Politics has always been and still is the politics of the elite.

Within the elite, criticism is a ploy, a gambit in a power play. Criticism such as Rajendra's, based on public accountability and unlinked to a bid for personal gain, is seldom understood or accepted, seldom suffered lightly.

It is a dangerous game. Even Rajendra's enemies admit he is not short of courage, but in the end that may not be enough. Some of the Draconian measures he lampoons in "Animal & Insect Act" could easily cost people like Rajendra their freedom.

"My position in Malaysia is very tenuous," he admits. "But the only alternative is silence, which is no alternative at all."

**"It becomes no longer a matter of choice,
but the moral obligation and bounden duty
of every responsible writer
to bear witness to the times he lives ..."**

Meanwhile, there are plans to publish a collection of his critical essays from The Star and elsewhere, and his sixth volume of poetry has gone to the publishers. The title poem is "Hour of Assassins", dedicated to the memory of Dr Walter Rodney, Third World historian and political activist and Rajendra's friend, murdered in his native Guyana.

The book is to be published by Bogle-L'Ouverture, a firm founded by Rodney's long-time friend Jessica Huntley specifically to publish Rodney's books, and now a leading Third World publisher.

"Jessica wanted to publish 'Bones & Feathers', but, like a fool, 1 wanted it published here," Rajendra said. "Though I don't regret it -- I've done what I can here as far as local publishers are concerned,

but I haven't had much joy with them. Probably more people will read my books if they're published abroad."

Each of his books has been better than the last, and "Hour of Assassins" is no exception. Rajendra's earlier work, including many of the poems in "Bones & Feathers", was written for live performance with his Third World Troubadours, which he formed in 1972 with musicians Cecil Roberts of Sierra Leone and Helio Diaz Pinto of Brazil.

The group, which had sprung from the Black Voices Forum Rajendra had started in London's old Troubadour folk club, toured Britain, Europe and North America for the next three years until Rajendra returned to Penang.

Silence of print

Some of the poems from this period, shorn of their vibrant Afro-Brazilian backing and reduced to the silence of print in book, lost something in the process, while others, written more recently, seemed a bit unsure of themselves. Rajendra himself says in retrospect that he has doubts about some of the poems in "Bones & Feathers". "Some of them should not have been published at all."

It is not that he rushes into print. He often spends years crafting a poem, belying their freshness and immediacy, and fully 80 per cent of what he writes is never published. It is simply that he has been maturing steadily.

"Refugees & Other Despairs" was a definite improvement, stronger and less patchy, but still transitional compared to "Hour of Assassins". Though he regularly reads his poems in public, at meetings, in schools and even factories, his major audience now consists of readers, not listeners, and his work has come to terms with this.

The new book achieves a full transition, without loss. Now the beat is fused into the written words, the assonance and dissonance are part of the rhythmic structure, giving the flow of word and their meanings powerful emotional undertow:

> When small liberties
> began to fray...
> When their constitution
> was being chipped away
> When their newspapers
> were shut down

When their rule of law
was twisted round
When might became right
and their friends
were carried off screaming
in the pitch of night...
They chose silence
feigned blindness
pleaded ignorance.
And now when the shadow
of the jackboot hangs
ominous over their beloved land
they walk as zombies
unable to distinguish right from
wrong from right
their minds furred with lichens
like the dark side of trees.

These poems are vintage Rajendra. Like his earlier work, they will travel well, and are bound to turn up in the most odd places.

POETRY:
Strength underpinned with skill

by Keith Addison

Published in Far Eastern Economic Review, June 23 1983, and Sunday Star, Malaysia, June 26 1983

Hour of Assassins by Cecil Rajendra. Bogle-L'Ouverture Publications, London. £2.95 (US$4.50).

CECIL Rajendra is Malaysia's best-known poet, but he is much more than that: he is a one-man pressure group, committed to awakening people to the social evils that beset his country and the world in general. His poems have been internationally acclaimed, but in Malaysia he is a highly controversial figure with as many detractors as admirers, and this book -- his sixth and his best so far -- will probably win him as much vilification as praise there.

It is difficult to be indifferent to Rajendra: his vitality ensures a response of one kind or the other, and in this book the familiar strength is underpinned by a more deft skill with words, and a deadlier aim for his barbs, than can be found in his previous anthologies (Bones & Feathers, 1978, and Refugees & Other

Despairs, 1981). The sacred cows, pompous myths and hypocrisies of established power emerge mauled, exposed, discredited, deflated, ridiculed or lampooned.

Local establishment apologists will no doubt take the bait, and respond as shrilly as they have done in the past. For instance, his legal peers (Rajendra is a lawyer and runs a practise in Penang) will not relish the distinction he draws in poems like Proper Attire between justice and the legal rigmarole with its "paper-shifting inanities".

The local literary establishment, staunchly formalist, has reviled Rajendra's work on account of its social commitment, which is seen as a "pollution of literature" and "artistically gross," but Rajendra has paid no heed to these admonishments: the latest volume has more social content than ever, as well as a biting parody of the whole detached "art-for-art's-sake" approach in Instructions to True Poets: "You must concentrate on precious things like love & loneliness; you must steer clear of obnoxious cliches like blood & dying children."

Religious establishments, whether Islamic or Christian, also come under attack. There are poems about the plight of rubber tappers, dispossessed farmers, fishermen "developed" off their beaches, the homeless, the hungry, the politicians who change their tune once they are in power; businessmen who cash in on other people's heritages; all the modern madnesses of war, the arms race, ecological ruin -- it is all there, cuttingly and movingly.

But Hour of Assassins is more than a catalogue of evils; much of it is also fine poetry. Rajendra's art has developed steadily through the years, and though he is still inconsistent, in many of these poems he succeeds in taking his readers (those of them he does not antagonise!) with him, through subtle rhythms in the written words that complement the subject matter and cut the dross from the images.

The title poem echoes Rajendra's grief at the murder of his friend Walter Rodney, author of the classic How Europe Under-developed Africa: "And now I cannot sleep, but turn over and over those too brief moments we ground together, clasped hands across three Continents, straightened the past, mapped our visions, exchanged those dreams …" He despairs at "the asafoetida memories of a lifetime of lives truncated in full flower". But there is also his Song of Hope, a litany against despair.

And, as well as the diamonds studding the ripened fingers of

chauffeur-driven "mems" pinching a brinjal at a market stall, set against the tears of a refugee child, or the awful sameness of modern suburbia's "photo-copy lives", there are poems about ordinary yet magical children, trees and the evening wind, rainbows in puddles of oil-slicked water, about love -- in fact, about all the "precious little things" he lampoons in Instructions to 'true' poets.

Rajendra is a true poet. "It becomes no longer a matter of choice, but the moral obligation and bounden duty of every responsible writer to bear witness to the times he lives in and to put his life and his work at the service of humanity," he said in his address at the Asian PEN Conference in Manila. Why do so few have the courage?

Books by Cecil Rajendra

Bones and Feathers, 1978, Heinemann (Writing in Asia), Hong Kong, ISBN 0686603338

Refugees & Other Despairs, 1980, Choice Books, Singapore

Hour of Assassins, 1983, Bogle-L'Ouverture Publications, London, ISBN 0 904521 29 X

Songs for the Unsung... Poems on Unpoetic Issues like War and Want, and Refugees, 1983, World Council of Churches, Geneva, No. 19 in the Risk Books series, ISBN 2-8254-0785-2

Child of the Sun, 1986, Bogle-L'Ouverture Publications, London, ISBN 904-521-37-0

Dove on Fire: Poems on Peace, Justice and Ecology, 1986, World Council of Churches, Geneva, ISBN 2-8254-0899-9

Lovers, Lunatics & Lalang, 1989, Bogle-L'Ouverture Publications, London, ISBN 0 904 521 47 8

Broken Buds, 1994, The Other India Press, Goa, India, ISBN 81-85569-08-8

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Leave the farmers alone

by Keith Addison

Book review published in African Business, August, 1986

Stories by Keith Addison

Tai Long Wan
-- Tales from a vanishing village

Introduction

Full story

Tea money

Full story

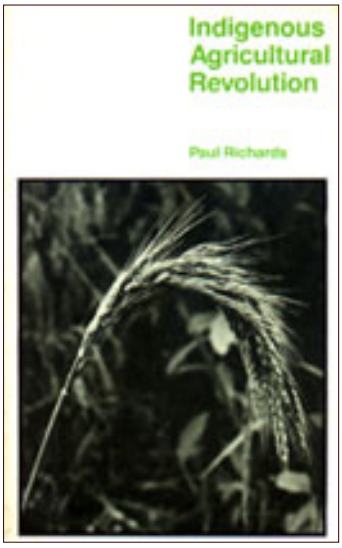
Forbidden fruit

Full story

No sugar

Full story

"Indigenous Agricultural Revolution -- Ecology and Food Production in West Africa", by Paul Richards. Published by Hutchison University Library, London, 192pp. £7.50 ISBN 0 09 161320 5



Dr Richards holds that agricultural research in developing countries is generally out of touch with the needs of the majority of farmers, and can do more harm than good. While not an original view, it's refreshing to hear it from an agricultural researcher.

Richards delivers a damning critique of the agricultural scientist's whole approach to development: ethnocentric bias, elitism, blindness to the inappropriateness of temperate-region techniques to the tropics, ignorance or disregard of local ecological and sociological conditions, inadequate field research and a lack of feedback.

All lead to hopelessly inappropriate research goals or, worse, imposing preconceived and simplistic ideals disregarding complex and diverse ecological interactions, with disastrous results.

The ill-founded attempt to eradicate tsetse fly so that stable, mixed farms (the European model) could replace the "wasteful" and "primitive" shifting agriculture preferred by peasant smallholders is a case in point, and Richards provides a good analysis of this.

Similarly, the drive to mechanize has proved an expensive white elephant, and, often, so has irrigation -- one scheme saw rice yields *declining* to a third of the levels the peasants had achieved before the scheme was built.

Richards casts serious doubt on the prospects of current research initiatives such as the attempts to impose an Asian-style Green Revolution on West Africa, with its "standard packages" of high-yielding (or rather high-response) varieties plus chemicals: here research is even more centralized, even less concerned with local conditions, and his analysis helps to explain why the scheme has gained

Treasure in a bowl of porridge

Full story

Hong Kong and Southeast Asia
-- Journalist follows his nose

Nutrient Starved Soils Lead To Nutrient Starved People

Full story

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Full story

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A timeless art
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so little ground.

His main thrust, however, is not merely a negative criticism of the scientific establishment, but rather that the capabilities of the peasants themselves have been grossly underrated.

He shows them to be ecologically aware, with sound reasons behind most of their techniques, and much given to experiment and innovation. Often they have been ahead of the scientists: Richards details several cases where scientific studies have "re-invented" techniques already widespread among peasants.

He presents a convincing case that, viewed in its full ecological context, shifting cultivation, rather than a primitive stage in agricultural development and thus in dire need of "modernizing", could be the best option for farmers with an excess of land and a chronic labour shortage.

The cultivators' "sloppy" land clearance emerges as an anti-erosion device, while their "undisciplined" and "unhygienic" intercropping practises (from 30 to 60 different crops per farm, with infinite local variations) spread the risk of failure and confer benefits of pest-resistance, soil conservation, a varied diet and, indeed, productive efficiency, without the insoluble labour bottlenecks that the more specialized approach the researchers generally advocate would involve.

With nature

The shifting system itself is ecologically educational in exposing farmers to a variety of conditions -- demonstrated in the way peasants adapt themselves to the tropical environment, so different in its local variations and ecological complexity from the temperate regions the researchers are more used to.

Lacking the population pressure and labour resources behind, say, Asia's terracing and irrigation systems, West African peasants work with nature, capitalizing on local diversity rather than trying to impose greater uniformity and control on the farming environment.

Two case studies corroborate Richards' view that the peasants' ecological sense and innovative talents are "one of the most significant of rural Africa's resources", which development and educational agencies must learn to tap.

However, poor communications in the rural hinterland exacerbate the "invisibilility" of peasant initiative -- and the peasants themselves, from long experience of taxes, demanding politicians and inequitable relations with the towns, often mislead outsiders about their productivity,

Health hazards dog progress in electronics sector
The dark side of electronics -- what happens to the health of workers on the production line

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Mamelodi
Finding Tom Hark
Return of the Big Voice
Brother Jake

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preferring the low profile of a "subsistence backwater".

Farmers are thus excluded from the process of research design, find the results irrelevant to their problems and continue to "rely on their own systems of knowledge and research procedures -- systems and procedures of which scientists in the 'formal' sector are often quite unaware. At best the two systems pass each other like ships in the night. At worst they duplicate effort, or compete destructively."

It is possible that Richards errs in the opposite direction to his peers in his admiration for the peasants. For instance, a common criticism of the shifting cultivators' "slash-and-burn" methods is that they fail to return the organic matter to the soil, and Richards is not entirely convincing in countering this.

He seems to see humus merely as a provider of nutrients for plant growth, ignoring its considerable role in increasing the stability and water retention of soils, both problems the peasants acknowledge.

He argues that composting is too slow and laborious, but finished compost can be produced in a few weeks in tropical conditions (the farmers leave cut brush for several weeks to dry before burning), and less laborious methods should not be beyond the capacities of these inventive farmers, accustomed to integrating nature's diversity and to smoothing out labour needs. Composting would also avoid the vulnerability of the "burn" to early rains.

Richards offers many useful suggestions, first among which is to abandon the "top-down" approach. One of the best sections of the book is his model Field Survey, a thoughtful, practical and thorough approach to how development should be tackled if projects are not only to "work" but to provide satisfactory answers to the questions "who benefits?" and "at whose expense?".

He advocates "sideways extension" -- formal-sector assistance in spreading the best local agricultural innovations -- and "participatory research", where problem definition and much of the research work itself are handled by groups of farmers, with scientists serving as collaborators and consultants. The training of investigators needs to involve far more fieldwork and participation if they are to fulfill the more useful role of "catalysts and facilitators" rather than experts.

Richards is not blind to the obstacles on the path he proposes, but it is the correct one if real development is to take place.

-- Keith Addison

African Business

August, 1986

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Health hazards dog progress in electronics sector

by Keith Addison

Published in Asian Business, June 1982

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Hong Kong's high-flying electronics sector is not all glamour. There's a dark side as well -- what is happening to the health of workers on the production line. Keith Addison reports

The findings of two major studies of Hong Kong's second biggest industry -- the electronics industry, with HK$15.7 billion in exports in 1981 -- could have a crucial bearing on the industry's development in the coming years.

The first, by an independent economics research group in collaboration with a local community health centre, threatens to shatter the industry's reputation of providing its 95,000 workers with the cleanest, safest working environment in town.

The second, by the government sponsored Hong Kong Productivity Centre (HKPC), may precipitate a series of interventionist measures in contrast to the government's largely laissez-faire policies.

The two studies have a common cause: the unbalanced growth in manufacturing the HKPC hopes to redress and the angry denials which greeted the early findings of the health study are both symptoms of the quick-buck mentality on which local investment in the industry is largely based.

The industry's "clean" image was first questioned in July last year, when the Kwuntong Occupational Community Health Centre conducted a study backed by the Christian Industrial Committee and the United Christian Hospital and found evidence of widespread damage to eyesight and hearing, symptoms of stress and a variety of health problems caused by exposure to dangerous chemicals among electronics workers.

A press statement issued soon afterwards by the electronics group of the Federation of Hong Kong Industries angrily denied the existence of any health hazards. The electronics industry was the "cleanest and safest industry in the world", providing "one of the best, if not the best, working environments".

The report was sensationalist, without foundation, vindictive,

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irresponsible, slanderous, unacceptable and highly damaging, the statement charged. It could frighten away workers and perhaps force some factories to relocate outside Hong Kong. It could also hamper government efforts to attract high-technology industries from overseas and to encourage diversification of Hong Kong's industries.

"We strongly urge the government to state its position on this type of detrimental activity," the statement said.

Taken aback by the fury of this response, the Kwuntong group, which had not yet finished its study, appealed to its research partner, Asia Monitor Resource Center, which entered the fray with a long and authoritative letter published in most of Hong Kong's leading newspapers, supporting the Kwuntong group's claims.

Serious hazards did exist, claimed Asia Monitor co-director Tom Gassert, citing the findings of work by the International Labour Organization and of the US government-sponsored Project on Health and Safety in Electronics (PHASE) being conducted in California's famous "Silicon Valley".

He slammed the local industrialists' lack of concern and the Labour Department's inadequate approach to the whole issue of chemical dangers in the workplace, as well as outdated government controls on dangerous chemicals.

Inadequate warning system

The next development in the controversy was the publication of the results of a survey of local electronics workers conducted by the Hong Kong and Kowloon Electronics Employees General Union, which had found that 70% of those examined were suffering from job-related health problems.

Despite all this smoke, the Labour Department's deputy chief factory inspector Yip Yuk-lun asserted in an interview that there is no fire: "We do not share the opinion of the Kwuntong group or the Asia Monitor Resource Center," he said. "The electronics industry, because of its cleanliness and good working environment, gives us very little trouble."

He waved away charges that workers were being poisoned by toxic fumes from molten solder and chemical fluxes: "I can assure you that all soldering baths have localized ventilation systems and exhausts."

He admitted there was a problem with corrosive solvents and cleansing agents because workers were reluctant

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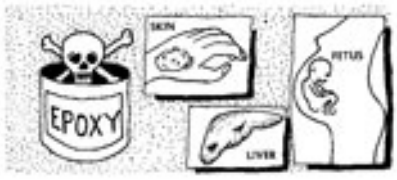
to wear the required protective gloves, but his inspectors informed workers of the dangers of the chemicals they were working with.

He also admitted his department was understaffed, with only 174 inspectors to visit 47,000 factories, but he insisted that his staff were in touch with most workers handling hazardous processes in the electronics industry's 1,115 factories.

Yet despite the Labour Department's publicity campaign, workers say the only warnings they have ever seen posted in their factories are no-smoking signs; they have never been told of hazards connected with their work.



Health researchers have seen factory girls (most electronics workers are female and young) removing nail polish with such deadly solvents as benzene and trichloroethylene. Benzene causes fatigue, loss of appetite, insomnia, nosebleeds and can cause leukemia, but it is still widely used by the industry in Hong Kong, despite warnings in literature printed by the government's Labour Department.

The Labour Department rates trichloroethylene as slightly hazardous, but according to the findings of the PHASE group in California, exposure to its volatile fumes causes headaches, tremors, nausea, vomiting and insomnia and can lead to heart damage, kidney damage, liver disease, inner ear damage and brain damage, and there is evidence that it can cause miscarriages and birth defects.

It also causes skin damage and dermatitis and prolonged use can cause finger paralysis. It is in common use in Hong Kong electronics factories.

Other problems

Workers interviewed in several areas said their employers did not insist that they wear gloves, and one worker said he would not wear them even if ordered to because they slowed down the work: basic wages are low and it is only through production bonuses and overtime that most workers can make ends meet.

In any event, gloves are not the answer. Recent US government tests showed that most brands of gloves allowed seepage within minutes. The Labour Department recommends the additional use of a barrier cream, but creams are even rarer than gloves.

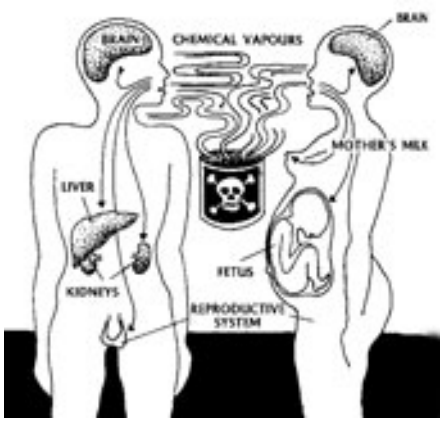
Yip's assurance that all solder baths have localized exhausts is not true. For instance, the solder baths and acid baths used in the tin plating

process at Semiconductor Devices in Aberdeen have no localized exhausts. Neither is the tin plating room air-conditioned: instead there are two extractor fans, one at each end of the room, and two other fans. That is neither adequate nor particularly unusual.

The point is that not all soldering work involves solder baths. Many workers are employed on touch-up work after the components have passed through the bath, using hand-held soldering irons and wire solder, and the fumes from solder and flux come straight up into their faces. None of these workers is adequately protected.

All the soldering work at Applied Electronics, also in Aberdeen, is done by hand, with no local exhausts and poor ventilation; the fumes are visible and the smell suffocating.

At the Contec factory in Kwuntong, one of the best equipped local electronics factories, the tin plating process is fully automated and properly ventilated, but long lines of touch-up workers using hand-held soldering irons are not protected at all.



Solders contain tin, lead, antimony, arsenic, cadmium, silver and zinc. Exposure to the oxidized fumes of these metals can cause anaemia, digestive problems, nerve damage, lung problems, heart trouble, reproductive problems and increased cancer risks.

Fumes from fluxes cause a range of ailments affecting the skin, eyes, nose and throat, chest, stomach, kidneys, liver, nervous system, heart and reproductive system, and increase cancer risks. Similarly serious problems are associated with chemicals found in the epoxy resins, hardeners and solvents used to make printed circuit boards.

There are other problems, not associated with chemicals. The tremendous pace set on the production lines produces stress symptoms; workers spending long hours, often illegally long, assembling micro-components under powerful microscopes suffer eye strain and permanent vision impairment; high noise levels exacerbate hearing problems caused by chemical exposure.

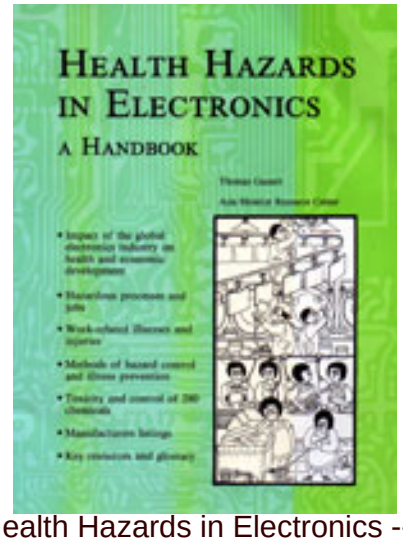
Testing for vision and hearing impairment is simple, and both the Kwuntong group and the union did this in their studies, but determining the effects of chemical exposure is more difficult, often entailing complicated laboratory analysis of blood samples and tests which cannot be done in Hong Kong.

Local electronics workers have a high rate of mobility between different jobs in the same factory and between factories, which makes it extremely difficult to trace the exact causes of their health problems.

Different jobs mean exposure to different chemicals at different intensities for different periods of time, making the task impossibly complex, and virtually nothing is known of the synergistic effects of different chemicals combining with each other in the body.

Of those examined by the Kwuntong group, 56% had vision deficiencies and 30% had hearing problems. Of those surveyed, 30% had hearing problems and 73% complained of noise in the workplace. Half of those doing soldering work had no local exhaust systems and 31% of workers doing hand soldering had eye injuries from sparks and splashes, while most complained of irritation from fumes. Nearly half were in daily contact with chemicals.

The most common problems found were eye strain, headaches, drowsiness, insomnia, poor vision, pains in hands and feet, dizziness and backache. About 80% thought their health problems were associated with their work and about 10% had been assured by their doctors that this was so.



"Health Hazards in Electronics -- A Handbook", by Thomas Gassert, 1985, English, 411pp (ed. Keith Addison) -- quick-reference, action-oriented, thorough information on health hazards faced by workers.
Available from Asia Monitor Resource Center
http://www.amrc.org.hk/resboks.htm

"Most of the problems could be expected," said a doctor who was associated with the study. "What we found corresponds well with findings in western countries." The union, which had 500 of its members medically examined, produced similar results.

The Asia Monitor Resource Center is currently incorporating the Kwuntong case study into a general primer on chemical hazards in the electronics industry for use by workers and labour organizations throughout East Asia, to be published later this year in English, Chinese and all the ASEAN languages.

The project is going ahead in spite of the controversial expulsion from Hong Kong in March of American lawyer Christine Vertucci, who had headed the project.

Mounting awareness

The centre has assembled what it claims is an unrivalled collection of authenticated information on chemical hazards from world-wide sources and will use this information in conjunction with the Kwuntong group's findings to produce an easy and thorough reference for workers to find out what chemicals they are using, what hazards they represent, and what can be done about it in terms of protection and prevention as well as the highly restrictive labour laws of many East Asian countries.

The project has already attracted interest from local medical people and the universities and from international bodies such as the World Health Organization (WHO) and the International Labour Organization (ILO). It is very much in line with a recent appeal for co-operation by governments, employers, workers and specialized groups in a joint International Program on Chemical Safety sponsored by the ILO, WHO and the UN Environment Program (UNEP).

With some 50,000 chemicals now in daily use, and between 500 and 1,000 new chemicals added each year, often before their toxicity has been assessed, the problem of analysing risks of health hazards and seeking ways to prevent them had become enormous, the ILO said. The proliferation of new chemicals had created a serious research gap, while industrial experience and epidemiological studies continued to reveal more areas of danger.

In Hong Kong, a growing worker awareness of the problem will ensure that it will not simply go away, no matter how much local industrialists and perhaps the government might wish it to do so. It is a serious problem and sooner or later it will have to be dealt with.

"The difficulty lies in the fact that Hong Kong entrepreneurs don't like putting capital investment into these areas," said Dr Edmond Chan, who is in charge of the Hong Kong Productivity Centre's study of the electronics industry.

"They want a quick return on their money. Our survey of the industry has revealed that the average break-even period a local manufacturer requires is only 2.9 years.

"It is not possible to isolate one problem like this: you have to look at the whole thing. For instance, if you look at the average company, the reason they set up a production line is that they already have an overseas order on which they know they can make a profit.

"So they set up a production line with the minimum of capital investment, and if they do not receive a second order, they simply close

down the line. If they had their own marketing outlets and expertise instead of relying on orders from trading houses, that would not happen, and they would be able to sustain a longer-term type of production which they would be more willing to invest capital in."

Rising labour and land costs have made it increasingly difficult for foreign suppliers to continue manufacturing components in Hong Kong, and this has been a major factor in the transfer of investment from foreign to local interests, accompanied by a rapid shift in product emphasis: between 1976 and 1980, components and parts fell from 40% of total export value to slightly above 20%, while consumer electronics -- quartz watches, TV games, radios, radio cassettes, Walkman-type stereos -- grew from 50% to over 70%.

In terms of quick profits, that is a favourable trend as the market for consumer electronics is big and Hong Kong's highly flexible industries are well equipped to deal with it.

But it is also an unhealthy trend, for the consumer market is not stable: demand for fashion products follows economic trends much faster than that for components or industrial electronics, and there is also the problem of protectionism. The heavy emphasis on consumer products is endangering the electronics industry's ability to provide a stable substitute in the economy for the ailing textiles industry.

First steps to solutions

"Japan, Taiwan, South Korea and even Singapore are all concentrating on high technology industrial electronics now, but in Hong Kong we are seeing the reverse trend, because there is no mechanism here to guide industry in that direction," Chan said.

"Development of microprocessors and products using microcomputers for control of manufacturing processes is exactly the area our industrialists don't want to go into, because investment is much higher and much longer-term. But they will have to be persuaded to do so.'

There are other difficulties: the necessary support industries -- metal and metal finishing, precision engineering, computer peripherals manufacturing -- are almost non-existent.

With this in mind, the HKPC organized the Electronics Show '82 early in March, to help local manufacturers find appropriate ancillary machinery, followed by the Machine Tools Exhibition '82, which aimed to help upgrade the local metal working industry.

There is also a serious lack of local expertise in microcomputer technology, but another project under Chan's supervision is designed to

begin to counter this lack.

"We have started a microprocessor application laboratory, the first application oriented research laboratory to be operated by the government," he said.

"The purpose is to build up local expertise in upgrading manufacturing technology, both in terms of process and product design. It is still small, but it is a beginning. We have a staff of 15, which will soon be increased to 20. We are designing products using microprocessors and systems using microcomputers for process control to upgrade manufacturing techniques, for use by Hong Kong industries. We will also provide a consultancy service.'

Another important area the study team is investigating is the possibility of promoting inter-company collaboration in the electronics industry.

"This is another of the local industry's weaknesses," Chan said. "Local manufacturers are very competitive, but they often end up cutting each other's throats to the detriment of the industry as a whole. We have to find ways of getting them together, though it will be difficult.'

Longer-term investment could obviously be facilitated if small companies were to share the costs of product development and overseas marketing operations. "We plan to intervene a little bit here and there, so that the companies will be able to develop further on their own," Chan said.

"The government is very reluctant to change its laissez-faire policies, but they will probably be able to swallow the sort of thing we are planning. They do know that if industry is going to diversify, they have to intervene; there is no other way."

It is a crucial problem, for unless the electronics industry develops high-technology expertise other industries will not have the means to upgrade their manufacturing processes to stay competitive in the international market.

A new industrial revolution centred on the electronics sector could provide some of the answers to the industry's occupational health problems. A work force acknowledged as a valuable resource -- instead of mere machine fodder -- is obviously worth conserving over the long term.

-- Asian Business, June 1982
(Illustrations from "Health Hazards in Electronics -- A Handbook")

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Death of a Toyota

by Keith Addison, Hong Kong, 1997

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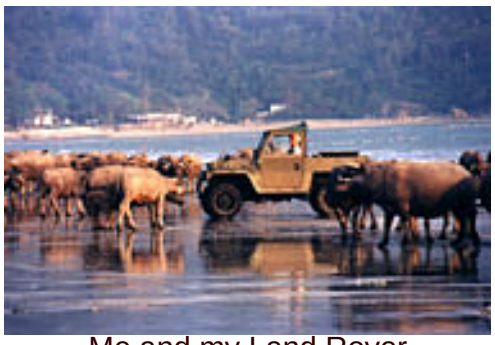
Postscript: The 4x4 jihad

THE old red Toyota FJ40 Land Cruiser was an even sadder sight than the last time I'd seen it, standing in Tai Long Wan village square rusting away, piled full of junk and growing roots. That had been two hot and very wet summers ago, and only 200 yards from the sea. Now friend Roger, who owned it, wanted me to move it, me and my Land Rover. But it didn't look like it was going to agree.



Me and my Land Rover
(photograph Dan Groshong)

The last time I'd been in the village the Toyota hadn't been alone: parked nearby were Roger's immaculate white Jeep Wrangler, his big beige Mercedes saloon, his Suzuki SJ410 long-wheelbase 4x4, his Yamaha RD350 kid-killer bike, seized, and his two big 250-hp powerboats. This didn't leave much room in the square for the use of the other villagers, and it was their square, not Roger's. It was a source of friction, but Roger couldn't find anywhere else to put it all. He came to visit me at the old farm in the mountains I was living in at the time and immediately eyed the farm sheds: "Can I put my cars here?" No way! A boat maybe? No!

Anyway the villagers were winning. The Jeep was gone, one of the boats was gone, and the Suzuki and the Mercedes (now resprayed mafia black) were both in daily use, which left one boat, the dead bike and the red Toyota. And now the Toyota had to go too.

That wasn't quite how Roger put it. The body was badly rusted, he said, so he'd bought a new body for it in Canada. ("Don't contact us if you live in a wet state," the dealer's Web page said.) Later, probably after having a closer look at it, it turned out he'd also bought a new frame, in Australia. Well, he hadn't actually bought the body and the frame yet, but he intended to. The engine, diffs and shafts were still fine, he said, so he'd cut them off with a torch and build a new one, fine car, the FJ40, well worth saving it. Surely so, but I guessed that line failed to impress the villagers any longer, they wanted it gone, today, now. I stared at the crumbling wreck, up on a jack with one wheel missing.

"No problem," said Roger, "it had a flat, so I had it fixed." He set to work putting the wheel back on, made sure it turned and let the jack down. "Right!"

He wanted me to tow it down to his house, one of the new three-storey "Spanish villas" the villagers started raising on their defunct

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Full story

Tai Long Wan valley

paddyfields a few years ago instead of rice. This meant pulling the old wreck round the corner, off the road, up a bank, over a sort of wall, then across two steel beams over a stream before bumping it down to the paddyfield.

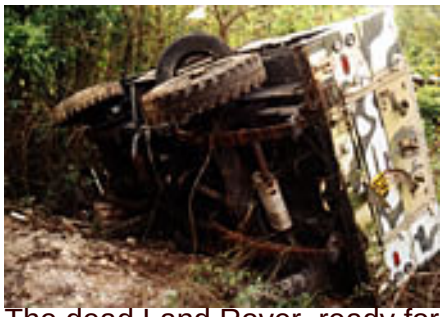
"You're kidding," I said.

"That's how I got the Wrangler down there," he said. (In fact the Wrangler was now parked in his living room, he'd somehow got it in through the french windows. "Only place it won't rust," he'd told me.)

"Oh," I said. "Well. Do the other wheels turn?"

"Um," said Roger, "let's pull it away from the wall first. Have we got a cable?"

I had a cable. Actually it was Roger's cable -- I'd ripped it off another of his cars, a '73 Land Rover Series III military lightweight truck, utility, 1/2 ton like mine he'd picked up five years earlier when it seized and towed into the bushes for safekeeping near Shui Hau, a village a few miles away, where it had since rusted to death. I'd been pillaging it for spares. He'd dumped another ex-Land Cruiser there too.



The dead Land Rover, ready for pillaging

I turned the Land Rover so its big NATO rear towhook faced the Toyota's rather smaller rear towhook, and we fitted the cable. I transferred to low ratios and pulled; the Land Rover roared and strained, the Toyota dug its toes in, the Land Rover roared some more, and pulled the Toyota 10 feet away from the wall. A glance in the mirror showed the nearside wheel, the one Roger had fixed, was turning, but I couldn't see the others properly. Then there was a ripping sound.

"Stop!" Roger yelled. I stopped and got out. We stared at the Toyota's rear bumper, now crumpled. "Man, this rust!" said Roger.

"Are the other wheels turning?" I asked

"Uh, no, only that one."

"Oh." There was a short silence.

"Can you pull it a bit further?"

"Sure." So I got back in and tugged it as far as the first house. "Stop!" Roger shouted as the edge of the rudderless Toyota bore down on the house's balcony pillars. It was Ah Fung the Shopkeeper's house, and Mrs Fung the Shopkeeper's Wife stood on the steps watching the spectacle with some interest. I grinned at her, she grinned back. We're old friends, I lived in Tai Long Wan for three years, back when they still grew rice there, one of the very last villages in Hong Kong still doing so.

"Want a beer?" she offered.

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-- a weekly column

Swag bag
Death of a Toyota

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-- On the wrong side of South Africa's racial divide.

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Sold into slavery
Mamelodi
Finding Tom Hark
Return of the Big Voice
Brother Jake

Curriculum Vitae

"Later," I said, nodding at the Toyota. She grinned again.

Roger finished his assessment of the situation and came across, the plan to tow the car down to his house abandoned, what a relief. "Can you pull it to the other end of the village?"

"I guess so. And then?"

"There's room for it there at the side of the road."

"Not for long though."

"No, I'll cut it up in a few days. So we need to turn it round. Can you drag it forward so we can turn it?"

I took the Land Rover around to the front of the Toyota and we looped the cable round the two mean-looking hooks on the Toyota's front bumper.

"Right!" said Roger. The Land Rover strained and roared, but with both front wheels locked the Toyota wouldn't move forward at all. I tried again, nothing. "Jerk it!" yelled Roger. "Maybe it'll free the wheels." Some hope. But I reversed a few feet and plunged forward, giving the Toyota a tremendous jerk as we hit the end of the cable slack. It bounced forward a foot and dug in again. I jerked it again, and there was a tearing noise.

"Stop!" yelled Roger. We'd pulled one of the Toyota's bumper hooks loose, tearing the metal underneath, and the rest of the bumper was badly twisted. "Hm," Roger ruminated as we stared at it. "Weak. They made the frame a C-section, it should be a box section, like the Land Rover. Actually they just copied the Land Rover. They improved a lot of things, the engine's much better than the Land Rover. They were selling 100,000 of them a year in the 60s. But the frame's weak. They break, here, behind the rear leaf spring." He showed me.

"Ulp," I said, appalled. "Anyway I can't move it."

"Unless we free the wheels," he said. "We need a big hammer, knock the rust away."

"Haven't you got one?"

"No."

We unlooped the cable, got in the Land Rover and prowled off to find a big hammer, but nobody in the village had one. Then we encountered Fung Wah, one of the younger men and another old friend. I once helped his mother a lot, a really sweet old lady, and after she died Fung Wah gave me the use of the family farm for a traditional farming research project.

"Hey," Fung Wah laughed, shaking my hand. "I haven't seen you for 10 years!"

"No," I said, "except for three times on the ferry."

"Yes," he agreed. "Ten years! I haven't got a big hammer," he told Roger. "But I'll try to find one." He loped off. We returned to the Toyota. Roger jacked up the front and took off one of the wheels, exposing a deeply rusted hub. Fung Wah returned with a largish hammer, well short of the required sledge, but Roger took it and fetched the hub a series of hefty whacks. Mounds of rust fell off. He whacked it

again, got underneath, fiddled with the shoe adjustment at the back of the hub with a screwdriver, wrenched powerfully at the hub, and it creaked and turned.

"Good!" Fung Wah shouted. He helped Roger put the wheel back on and tightened the bolts as Roger jacked up the other front wheel. A few whacks later that was turning too. The other rear wheel was less co-operative: Roger whacked and fiddled, but it wouldn't budge. "Beer," he said, and went into the shop, returning with a six-pack of Heineken. He whacked and fiddled some more, growling a lot, and two Heinekens later the hub reluctantly turned.

Fung Wah when he was a lad

"Ha!" said Roger, taking another beer. "When you get stuck in the middle of the desert you need someone like me."

That was probably true. Or something like him anyway. "Hopefully I'd have less rusty hubs," I hedged. He joined me on the step of the shop.

Meanwhile Fung Wah, having put the wheel back on, and also fortified by Heineken, climbed into the Land Rover and was playing with the steering wheel. He found my hat, one of the two-foot-wide pointed bamboo head-umbrellas Chinese farmers use in the fields, which I was using instead of a roof when it rained.

"Good!" he said, putting it on. He's a Chinese farmer and didn't look downright odd in my hat like I'm told I do, but like many Chinese farmers Fung Wah's a short guy and he looked totally silly sitting in my old army half-ton -- a very un-Chinese object, I suddenly realized -- trying to peer forward through what must have been only a narrow gap between the leading edge of the big hat and the spare wheel on top of the hood. I started laughing. Then he found the keys and started the engine. I stopped laughing.

"It's okay, he's got a licence now," said Roger. "God he looks funny!"

"Not if it's your Land Rover," I said, getting up. "Wah Jai, what the hell are you doing?"

"Nothing!" he shouted, putting it in gear and setting the car rumbling forward towards us in low first. What the hell, I thought, getting my priorities straight, he might demolish the village but he probably won't hurt the Land Rover. However, he brought the car to a smooth halt in front of the shop, engaged the handbrake, switched off, dumped the hat and climbed out, grinning at me.

"Oh, very good!" I said. "But you're too short."

"You're too thin!" he said. "I'm stronger than you!"

"No you're not," I said.

"Yes I am!"

I grabbed his hand and had him on the ground in no time, both of us

laughing. And I remembered having exactly the same argument 10 years before, and it ended the same way too, with Fung Wah on the ground, laughing. There was even a car involved, a Suzuki van. I was leaving Hong Kong and I gave it to Fung Wah, who badly needed a van, only he didn't have a licence, so I told him to get one. And now he finally had one. Steady people, these villagers, they don't hurry. I wondered what had happened to the van. "Have you got a car?" I asked him.

"No," he said. "I want to buy one. Do you know if any of your friends can sell me a cheap van?"

I said I'd ask them. Did he have a wife yet? No, and he didn't want one, he said, wives were too expensive and they were useless anyway. I laughed at him. One of the old village men of yore once told a field researcher that wives were cheaper than land when he was a lad, you could get a wife for a couple of pigs. But no longer, alas, and in fact Fung Wah really couldn't afford a wife, nor a $40,000 village wedding. His elder brothers spent the family money 20 years ago, leaving nothing for him (or his mother), and now he works for the Water Department, earning not very much, or he'd have a wife -- village wives are far from useless, they do more than half the work and they're skilful and strong, they're a hell of a good deal for a couple of pigs.

Roger reached a decision. "We have to clear the steering wheel so we can turn the car round," he said.

I peered in through the dirty screen at all the junk stored in the Toyota. "Can't see a steering wheel," I said. "Which side is it on?"

"The right side, dumbo." He looked at the locked driver's door, walked round to the other side and looked at that locked door, then stepped back and fetched the door a mighty kick. He's a big man, Roger, more like a bear, 6ft, 240 lb and a famed fighter, and he was wearing heavy boots. The Toyota reeled with the shock, shedding showers of rust flakes, but the lock held. It took two more kicks, then the door sprung back on its hinges. Roger reached inside, but he couldn't reach the junk covering the wheel from that side without taking out a whole lot of other junk first, which he seemed reluctant to do.

Roger's graveyard of jeeps

Just then his wife Tina arrived and sat down on the shop steps. "How're you guys doing?" she asked.

Tina's Chinese, but she was born and raised in England and in fact she's more of an English rose, she only recently managed to get her tongue round Hong Kong's Cantonese. Roger, on the other hand, is a Westerner, but he was born and raised on the island and could speak Chinese before he spoke much English, and in some ways he's more Chinese than they are.

"Doing okay, but we need the key to unlock the steering lock," Roger told her. "You've got the key."

"Have I?"

"Yes, won't you go and find it, please?"

"Where is it?"

"I don't know, you've got it somewhere."

"Well I'm not searching downstairs because it's full of cars, and I'm not searching your hell-hole on the top floor."

The red FJ40 wedged in next to the dead Land Rover

"Oh come on, Tina."

She went off, returning 15 minutes later with three keys on a ring.

"Thanks, that's them, great!" said Roger. "Where were they?"

"Top floor," she said.

Roger fiddled with the stiff driver-side lock, found the right key, got it in and turned it. With a bit of persuasion the door came open and some nondescript junk fell out, bits of washing machine or something. Roger pushed more junk aside -- a stray dashboard, some kitchen drying racks -- and reached in with his foot towards the pedals, but the floor was completely rusted and fell away as soon as he touched it. "No floor!" he laughed. He pushed more junk aside and slotted the key into the ignition, turned it and freed the steering lock. "Great, the steering's free." He climbed out and went to the front of the car, assessing how we'd turn it. I joined him.

The second dead Toyota

"The steering'll work?" I asked.

"Yes, it'll be okay."

"And the brakes?"

"The brakes'll work." Roger turned and walked towards the shop, slamming the Toyota door closed out of his way as he passed. He stopped dead, grabbed the door handle and tugged it, but it stayed closed. He said some hard words.

"What's wrong?" I asked.

"The key's locked inside," he said.

Meanwhile the sun was setting over the bay and some of the villagers were starting to return from whatever it is they do these days now they don't tend their fields much anymore. Sundown means dinner, and the good smells of traditional Chinese village home cooking filled the evening air. These people don't say "Hello", they say "Have you eaten yet?" instead, just to show what their priorities are. "Not yet," I kept saying as my stomach rumbled.

So Roger now had an audience, an openly amused one, face was at stake. He took the hammer, crouched into a low kung fu stance, touched the ball end of the head to the door lock, swung it far back and dealt the

lock a tremendous blow, hitting it spot on. Another blow, just as accurate, knocked the entire lock right through the door, leaving a neat hole. We were all very impressed.

Face restored, Roger tugged the door open and started pulling stuff out, throwing it out of the door -- bits of plastic piping, parts of an electric fan, lengths of wiring, an egg tray from a fridge, some kitchen containers, other containers, some old jeans. Some of the villagers were laughing again at the strange junk Roger had thought looked useful enough to keep, but he took no notice. Finally he was able to turn the steering wheel, and the front wheels turned too. "Let's turn it round," he said.

"Right," I said, getting in the Land Rover. I positioned it and we looped the cable round the Toyota's battered front bumper hooks again. Roger yelled instructions while somehow standing with one foot on the floorless Toyota's doorframe and the other working the brake while one hand steered and the other gripped the roof, and I pulled it away from the shop, shoved it backwards with the rear bumpers, pulled it forward again, pushed it back again, and so on, and we accomplished a four-point turn, or was it five, but at last the old Land Cruiser was pointing in the right direction -- out of the village.

"It's much easier when the wheels go round," I remarked. "What now?"

Roger considered. "Can you tow it to Shui Hau?"

"I guess so, if you can steer it and stop it. Are we legal?"

"Don't worry about it. Do you think there's room for it next to that Land Rover? Then I can cut it up there, as well as the other one."

"Should be room," I said, amused, sure that both the other cars had been towed into the bushes with just such constructive intentions.

Fung Wah climbed into the back of the lightweight behind me to keep an eye on the cable, Roger clung four-limbed to the Toyota, Tina brought the Suzuki 4x4 up behind in case anything fell off (probably Roger, I thought), and we set off through the village, creating much good cheer at the various dinner tables inside the open doors we passed.

The Toyota wasn't exactly rolling along, it had to be pulled, and the road up out of the valley is steep, but the Land Rover chugged up the hill without much effort, then along the flat winding bit at the top and down again to the main south Lantau coast road, taking it slowly, with everyone yelling a lot. We pulled onto the main road, crossed the big dam at Shek Pik and were climbing the hill on the other side when Fung Wah yelled "Shit!"

"What?"

"A bus!" We were taking up most of the road, not worrying much about white lines and stuff. I hastily moved us to the left. The bus roared up behind Tina and paused while the driver took stock, then passed us carefully, astonished passengers tugging at each other and pointing at Roger through the windows. "Wah!"

We pressed on, but halfway down the hill on the other side, with Shui Hau at the bottom, we had to stop for a while so Roger could hop

about in the road on one foot trying to get the cramp out of the other one from working the brake, cursing heavily, while another busload of interested passengers went past. Off again, and into the village, just as a police van full of coppers pulled in at the other end, damn. Too late to stop so I drove on towards them, fighting the urge to whistle nonchalantly. We rumbled past, Roger staring at the coppers over the roof of the Toyota, but somehow they all had their backs to us and didn't notice the strange convoy going past, very odd, I thought, shrugging. Fung Wah laughed in derision. We reached the turnoff to Roger's graveyard of jeeps, I tugged the Toyota over the pavement and we bumped up the narrow track.

"Stop!" Roger yelled. I stopped. He more or less fell off the Toyota and staggered about again, laughing this time -- "What a way to drive! And the cops didn't even see us!"

I glanced at the dead lightweight in the bushes next to the track, lit up by Tina's lights. Just like mine, only it was 24-volt and mine was 12, and instead of olive drab it was painted in white and black zebra stripes and didn't have any doors or a windscreen, let alone a roof. I had the windscreen at home -- I'd taken it off so it didn't smash when I'd used my lightweight to pull the old rustheap onto its side on top of some tyres, taking off the 4-wheel-drive box before putting it down on its wheels again.

This was when I'd discovered that you don't take a 4-wheel-drive box off a Land Rover, you take the Land Rover off the 4-wheel-drive box. I also discovered a whole new dimension in dirt -- a heady blend of severe rust, WD-40, the thick coat of black tar-based sealant under the car which the WD-40 melted, plus liberal applications of heavy-duty mosquito repellent, lots of sweat, and some blood, along with the usual measure of road-dirt, leaking oil, sand and stuff, and a tropical downpour. I don't recommend it at all.

Removing the Land Rover from the 4-wheel-drive box

This one isn't the only dead lightweight on Lantau. There's another 24-volt in the village of Pui O, in storage in a lot for the last four years with its engine shot, but it's been shunted to the edge of the paddyfield and is infested with creeper weed, and the rust is advanced. My lightweight only narrowly escaped such a fate -- it spent 18 months stalled by licensing difficulties next to a paddyfield in the village of Luk Tei Tong and was also full of creeper and encroaching rust when I eventually managed to rescue it. Two other old Land Rovers -- one a Series I -- were standing thus when they got incorporated into 20 feet of landfill and are now under a road instead of on one.

I wouldn't be turning this one on its side again -- Roger and Fung

Wah had just concluded that, with the other wrecked Land Cruiser taking up the far side of the track, the only space left for the Toyota was right next to the Land Rover, a tight squeeze, with the two old 4x4s tucked between a tree and a pile of scrap iron. Awkward -- I could pull the Toyota past the spot so I could push it in backwards, but the track was narrow there with a sudden rise and twist, and a big pile of bitumen slabs making a sudden 45-degree slope on the other side, which I'd have to move onto to push the Toyota in.

I did the first part by taking a run at the rise to get the Toyota far enough before the Land Rover lost traction and started skidding, but pushing it in next to the other lightweight was not a subtle business -- the only way I could do it was by sailing backwards down the bitumen slope and thumping the front of the Toyota with the Land Rover's rear bumperettes, shoving a bit, then backing off to do it again at a different angle. Four times, and the Toyota was parked. More crumpled, but parked.

The second dead Land Rover lightweight being eaten by weeds

I got out and stared at its bent front-end. Roger disentangled himself from the Toyota and was staring at the Land Rover's rear-end. "God," he said, "look at your bumpers."

"They're not bent, are they?" I asked, hurrying across.

"No, not even a scratch," said Roger. "Amazing -- what the hell are these things made of?"

"Just steel," I said. "But these T-sections in the sides make them really strong."

"No, I meant the car. Actually it is scratched," he said, bending to take a closer look at the right bumperette. "One scratch!"

Actually it wasn't scratched, it had just taken a lick off the Toyota's undercoat. Roger hasn't had much to do with Land Rovers, the 24-volt was already defunct when he inherited it and I think the only one he'd driven was mine. He'd helped me get it back on the road. "I like working on these cars," he'd said. "You can actually fix them instead of just taking bits off and replacing them with new bits." So he didn't know how strong they are. Neither did I really -- I'd often driven Land Rovers in South Africa years ago, but I'd never tried beating up a Land Cruiser with one before. I did used to know a professional game catcher who tested 4x4s by driving them fast over a bank into a dried river bed, and if they broke he wouldn't buy them. He claimed this was a fair test for what might happen to you when you're chasing a wildebeest through a thorn thicket. He said only Land Rovers didn't break.

"Strong!" said Fung Wah, slapping the lightweight's tailgate.

"Hungry!" I said, slapping my empty belly.

"Yes!" he laughed.

"Dinner," said Roger. Tina took off home in the Suzuki, to join us

later at a Chinese restaurant in Pui O.

"May I drive please?" Roger asked me. So polite!

"Okay, but it's not the kind of car you do 130 mph over the new airport bridge in."

"I know!" he laughed. And he drove very sedately.

Dinner was on Roger. We were joined by Ah Fung the Shopkeeper's eldest son Ah Ming, who drives Land Rovers for the Forestry Department, and a bunch of the local good ol' boys, eight or nine of us in all, and finally Tina, and the talk was about Land Rovers, Roger and Fung Wah shaking their heads in admiration and Ah Ming nodding wisely: he preferred the old ones, he said, stronger than Defenders, and leafsprings were better than coils, more stable in the rough. But it kept coming back to what a mess my lightweight had made of the old FJ40. Damn, I thought, now she's a hero -- it'll go to her head.

Meanwhile various hotpots arrived, were emptied, vanished, a chicken dish, a rich vegetable stew, and many beer bottles, and I'd just decided I'd had enough and had work to do and a deadline to catch when the real dinner was borne to the table in triumph: a massive platter piled at least 18 inches high with choice cuts of raw pork, beef, chicken, garoupa, abalone and squid and a boiler to dip them in, leaving a rich soup at the end. This was going to be an all-nighter, and if I was going to escape now was the time.

"Gotta go," I said. "Work to do."

A good decision -- I'm still hearing about some of the things that happened that night, some of them seriously heavy. And the lightweight is indeed famous -- nobody on this island, not even the local constabulary in their 90s and 110s, argues with my Land Rover.

And the mortality rate's changed. When I started this there were three lightweights in the bushes and none on the road, and one Land Cruiser in the bushes and three on the road, counting the red one. Now there are two FJ40s in the bushes and only one on the road (the fourth left the island), and two lightweights in the bushes and three on the road -- only 10 per cent short of Rover's old claim that 70 per cent of the Land Rovers ever built were still running.

Roger forgot his plan to restore an FJ40 and bought a lightweight himself, and so impressed a local friend with his talk of my beast's exploits that the friend bought one too.

Then there were three -- Land Rover lightweights at the Beach House

For a while all three were parked here at the Beach House at Pui O, while the "new" ones waited for their road tests. I was amazed at the interest they attracted: gawpers kept gathering at the gates, and people -- all kinds of people -- kept waking me up in the morning, hammering on the door to ask me if they were for sale. There's definitely something special about lightweights.

Roger also moved his powerboat, the Suzuki SJ410 4x4 died of rust and is now disintegrating on his lawn with the Yamaha RD350 in the back, and he sold the Mercedes, so the villagers got their square back.

And Fung Wah bought a car, not a lightweight and not a cheap van but a sleek silver-grey Toyota saloon -- what the coarser of my teenage friends used to call a "cow-catcher".

"Wow!" I said when he brought it to show me. "Smart! What did you pay for it?"

"$35,000," he said.

"But you could've bought a wife for that," I said.

"Not enough!" he laughed. A week later he drove it into a wall.

Death of a T*y*ta

Postscript: The 4x4 jihad

I just wrote this story for fun really, without any serious intentions of publishing it -- the whole incident amused me. Then some guys persuaded me to post it on one of the Land Rover Owners' mailing lists on the Internet.

"But it's long," I said. "Bandwidth."

"Never mind," they said. "Do it!"

So I did, and people liked it, it drew a lot of comment, really good feedback, and it started travelling -- it was published in a Land Rover Club magazine, and I think it's still doing the rounds.

But some of the feedback I got was a bit strange: they said some nice things, but with some odd comments as well, like this:

"The best part was where Roger used that tool #1 on the doorhandle!!" (Tool No. 1 is a hammer.)

That's not what I'd felt about it -- sure, I was rather amazed at how tough the Land Rover proved to be, but I wasn't trying to put the boot into the Toyota.

FJ40s can do the job (from dirttrack's cruiser page)

My own feeling about the story was that it would've been better balanced if I'd managed to fit in something about the fact that the toughest ride I'd ever done was in a Toyota FJ40 Land Cruiser like this one. I remembered it vividly, and I'd often wondered whether my Land Rover would've handled it so well -- up a steep river of deep mud churned up by fleets of huge lorries doing illegal logging in the mountains of the Philippines.

Now it seemed I'd taken sides in a war I didn't even know about, and had no sympathy with: Land Rovers vs Toyotas. Land Rover owners

HATE Toyotas. Why on earth? Isn't that a bit teenaged?

I responded to a message on the mailing list about the story, mentioning "Toyota", and got ticked off: "You know you're not allowed to say that word here!"

Sure enough, you can only say it like this: "T*y*ta", or even "T*y*ta L*nd Cr**s*r". Ridiculous. Look at this list message:

"At the risk of blasphemy, I will say that I have driven a T*y*ta RAV4."

Blasphemy? What is this, a jihad?

He goes on to say a lot of nice things about the RAV4, he "cannot find any account on which to fault the RAV4, other than -- it's not a Land Rover".

And so he HATES it -- "totally lacking in character", a "tin box" with a "pile of complicated alloy junk under the bonnet", and "it will look good, drive good, and feel good until 48 hours after the last payment is posted, then it will rapidly self-destruct leaving a pile of rust in its trail".

Come on -- Land Rovers don't rust? They most certainly do rust! According to all the complaints on the list, this is what Land Rover "character" amounts to: the doors don't close properly, the roofs leak, they're slow, uncomfortable, noisy, the electrical system is lousy, and something always need fixing. Unlike the RAV4. And why don't they have locking differentials?

Journey to Forever's Land Rover lightweight
(photograph Leung Kwong-fuk)

They're just machines, there to do a job. Toyota FJ40 Land Cruisers can do the job -- they're tough, capable and simple, and they've had 40 years to prove it.

We left the Toyota in Roger's graveyard of jeeps next to an old Land Rover lightweight that was even more dead than the Toyota -- nothing will survive that kind of neglect in that rusty place.

And as it turned out, neither of the two Toyotas in the graveyard was quite as dead as it looked. Some months later a Pakistani paid Roger good money for the pair of them, loaded them onto a lorry and shipped them off to Pakistan, fully confident he'd get at least one of them running again for another 20 years. I'm sure he succeeded.

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Zebra Crossing

-- On the wrong side of South Africa's racial divide

by Keith Addison

South Africa, 1974

Stories by Keith Addison

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-- On the wrong side of South Africa's racial divide.

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Kwela Jake

When he was only eight, Jake ran away from his home in Alexandra Township ("Dark City") north of Johannesburg. He took the six-holed tin pennywhistle he'd pestered his uncle to give him, and went to the city to play for white pennies on the street corners with other kids, dodging the police when they tried to catch him, sleeping at night in the backseat of a wrecked car on a disused lot.

They did catch him in the end, but by then he'd had six months of playing music for a living, and he was hooked for life.

His mother hugged him when the police brought him back to her, and then she beat his bottom with a straight and narrow stick until they were both howling. Then she sent him to school, in a place he couldn't run away from -- Moria, Mount Zion, three hundred miles north of Johannesburg, Holy Land to a million Black Zionist Christians. And she sent his brother Elias ("Shamba"), also a pennywhistler, with him.

The brothers spent the mornings in the classroom with the priests and their lessons, and the afternoons herding goats in the hills near the holy city.

One afternoon they were sitting under a tree talking about Johannesburg. After a time they fell silent, each longing for the racy life of the townships.

Jake took his flute and began to play, and Elias joined in. It was a new tune, vibrant with the fast freedoms of the street corners, and it swept them away. They played on and on, with only the goats to hear, until it was dark and they were breathless.

Forbidden fruit

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No sugar

Full story

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Jake stayed at Moria for five years, and then he and Elias went back to Johannesburg, and the streets. Soon they had a band: three pennywhistles, a bass made from an upended teabox, a bit of rope and a broomstick, and a skiffle guitar. Jake thrived -- this was better than the church choirs of Moria. And it could pay twenty pounds in an afternoon.

A year later a record company scout heard the band playing in the street and offered them a chance to make a recording. They went to the studio and recorded the tune Jake had composed that day in the hills of Moria. They called it Tom Hark.

The record started with the sound of money clinking down onto a pavement. Dice rattle, streetwise young voices call bets and argue, the dice stop rolling, cheers and groans as the coins are scooped up again.

Feet come running and an urgent voice calls: "E Bops, kom maak gou -- hier kom die kwela kwela van!" ("Hurry up, here comes the police van"). "Tom Hark" has been watching for police at the corner.

Jake rehearses his band in 1997 -- on the right is Zeph Ncabinde, who'd played on the streets with Jake 45 years earlier.

Dice and cash vanish, out come pennywhistles and guitars, and the gambling school becomes a kwela band (the music named after the police van) and they swing into the irresistible tune of Tom Hark. The police rumble past in their van. All clear -- the music stops, dice rattle down, a new Tom Hark takes his stand at the corner.

Tom Hark earned Jake and Elias studio fees of six guineas each (£6 6s 0d -- about US$12). Jake signed over the royalties on the record to Elias as a gift because Elias was broke at the time. Elias was always broke -- everyone was always broke. Except the whites -- so Elias sold the rights to a record company executive for £30 and bought himself some snappy new clothes.

The record sold a million copies, and then a million more, finally levelling off at about five million sales worldwide. It was even used as the theme of a BBC TV thriller series.

But the two young stars had already had all the money they would get out of it, and they stayed broke, still living the street life they'd described

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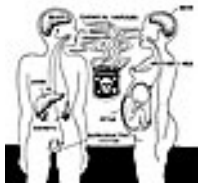

Mo man tai ('No problem')
-- "Write whatever you like" -- a weekly column

on the record.

"The police didn't like us playing in the streets," Jake remembers. "When they caught us they beat us up. But I didn't care -- the money was good.

"But on Christmas Day in 1958 I was playing in Hillbrow. The street was crowded with people listening to me. The police came. They beat me up, they kicked me in the face and broke my jaw. You can't play kwela with a broken jaw. Then they fined me for disturbing the peace."

After that he was too frightened to play in the streets again. He turned to the record companies for a living. They robbed him, but they didn't break his jaw.

For thirty years Jake's music has been his mistress. He worked in jazz, soul, pop and mbaqanga (township jive), always with success. There was the incredible thrill of playing by royal command to the Zulu king and to the King of Swaziland, of travelling to Europe and adventure, of having many names, and all of them famous. But he never managed to break the big-time barrier again.

He started whole new directions in music -- mbaqanga, the townships jive that swept Africa, was largely his origination. He helped and influenced scores of musicians, his music thrilled generations. He recorded about 250 records, many of them best-sellers -- but always for others to get rich.

The same golden wind that he wafted round the world still blows through Jake's music, whether he's blowing jazz on his flute, jive on his tenor sax or his alto, blues on his harmonica or kwela on his pennywhistles -- still his favourite, and he still has the original one his uncle gave him when he was knee-high.

When he plays it these days it's no kid that's blowing, though sometimes an old kwela tune among friends can shed his years until he looks sixteen again. He's deeper now, more subtle -- yet his pure and simple kwela sounds simpler and purer than ever.

Big Voice Jack

Bassline Jazz Club
http://www.basslinejazzclub.co.za/Biogs/BVJack/BVJack.htm

Big Voice Jack Returns With His Penny Whistle -- " I will keep

Swag bag
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on playing music until I am 90 or 100 years old. As long as God can spare me I will keep on making music." (Mail & Guardian. April '99)

Big Voice Jack has been at the forefront of the distinctive South African pennywhistle sound for five decades now and with a new album and documentary about his life out at the moment, the old man of the pennywhistle' is not slowing down for anything. Considered the leading pennywhistle player in the land. Big Voice Jack, who is now well into his sixties, still brings to his music the vibrancy, authenticity and spirit that is reminiscent of Johannesburg in the early 50's when the pennywhistle could be heard on street corners all over the city and Aaron Jack Lerole (his real name) was a kid with big dreams.

Jake meets the press in New York.

Big Voice Jack started his musical career at an early age in the dusty township of Alexandra on the outskirts of Johannesburg. In the late 40's and early 50's, Alexandra was alive with bands playing various styles of music. There were brass bands, jazz bands, bands playing marabi, boogy woogy and progressive jazz, but the sound that really captured young Jack's heart was the sound of the pennywhistle. On weekends in Alexandra, Big Voice Jack furthered his love for the pennywhistle sound by following his favourite bands through the streets of Alexandra as they marched and played. The group that captured young Jack's attention consisted of a rather bizarre lot of men who used to dress up in Scottish kilts and march through the streets playing pennywhistles and home made drums made from rubber and bottle tops. " We used to call them 'Amaskotish',"says Big Voice Jack. "I saw these men and from then on I urged my parents to get me a pennywhistle."

Big Voice Jack taught himself to play by rehearsing all the popular songs of the time. Songs like "In the mood" and "The Chattanooga Choo Choo", and once he became good enough he joined the older men and went out with them on weekends to play for money.

In 1952, Big Voice Jack recorded his debut 78 inch single with Troubadour Records called "Fislasiya Rhala". Over the next couple of years he recorded many singles and by 1956 he was starting to receive recognition for his unmatched skill with the pennywhistle. He formed a

band with his brother Alias Lerole, David Rhamamosa. Peter Khumalo and Zeph Ncabinde called, The Alexandra Shamba Boys and recorded an album that became hugely popular in the dancehalls and shebeens of South Africa. "Suddenly I had an entourage," remembers Jack, "and people used to follow me through the streets like I was a preacher." Jack and his band used to march from one end of the city to the other, playing and collecting money as they went. This was during the dark days of apartheid South Africa, and the band members were frequently arrested for causing a public disturbance. " We used to just pay the fine and carry on playing," says Jack. One of the other dangers at the time were the gangsters who would frequently pressurise bands for protection money. For this reason, Jack and his band used to carry tomahawks around with them for protection money. For this reason, Jack and his band used to carry around tomahawks around with them for protection. By the end of the 50's the pennywhistle had gained in popularity so much so that international audiences began to be interested in the sound. Jack had become involved with a theatre group called "Gibelani Madoda" and he accompanied them on his first international trip when they set off for a tour of Italy. The tour was to take Jack through the dancehalls and theatres of Europe where his pennywhistles were gaining new converts with every show.

In the early 60's Jack returned to South Africa and embarked on a solo career. It was at this time that he got the name Big Voice Jack because of the distinctive singing style he employed, a deep groaning style that striped his vocal cords forever. Jack's solo career took off and he put out many hit singles throughout the 60's and 70's, "Cherry Beat", "Big Voice Jack no1" and "Jacking Jack" were some of his more popular hits. In the 80's Jack was involved with many South African and international musicians. He worked with Malcolm McLaren, the maverick genius behind the Sex Pistols, and was involved in numerous other projects in television and theatre.

He continued to tour both locally and abroad, playing in Africa and in European countries like Switzerland, Spain, France, Austria and many others. However, it was at The Bassline Jazz Club in Melville Johannesburg that Jack's finest moment was set in motion. Jack was playing at the club and Dave Mathews, guitarist, songwriter and singer with the internationally acclaimed Dave Mathews Band, was in the audience. Dave's saxophonist had asked him to pick up a few pennywhistles while he was visiting South Africa and Dave approached Big Voice Jack after the gig to ask him where he could find them. Big Voice Jack decided to rather give his own whistles to Mathews. "I thought that I would never play in a big stadium in America, so I wanted my whistles to be there," says Jack."So I gave them to him."

Big Voice Jack's generosity was repaid when the Dave Mathews Band invited him to come over to the States and play two gigs with them at

the Foxboro stadium in Boston and the Giants stadium in New York. This invitation from arguably the hottest rock act in America at the moment is a fitting tribute to the lasting contribution that Big Voice Jack has made to South African music, and went down a treat. Jack's gigs with the Dave Mathews Band were recorded in a documentary by South African filmmaker Johnathan Dorfman called "Back to Alexandra." The film shows Jack on stage before an 88 000 strong crowd, jiving and jamming with the band like a man half his age. He went down so well that the band even asked him to play one of his own tunes, "Back to Alexandra," a song in which Jack gives vent to his lifelong hatred for guns.

He has just completed a memorable tour, is the star of a documentary and just to round it off, the old man of the pennywhistle has recently released an album, Colours and Moods, which will be released internationally through GMI. The album was recorded live at the Bassline in September '98 and mastered at the SABC studios. It features original material written by Big Voice Jack over the years, some of which dates back to the 50's. "The album has a live quality that makes you feel like you are watching the band as they walk through the streets of Alexandra. It has an authenticity and nostalgic feeling that makes it novel," says Brad Holmes, Big Voice Jack's manager. He has come a long way from the streets of the townships where he learnt to make his music, and if you listen to the energy, vibrancy and skill displayed in Colours and Moods, you have the feel that Big Voice Jack has a long way yet to go.

For further information contact:

Brad Holmes at The Bassline Management or Antos Sella at Gallo Music International Tel: (011) 788-0400 Fax: (011) 442-6190
Email: bassline@icon.co.za

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Johannesburg, 1974

Jake's face flickered in the flames of the log fire, his tenor saxophone flashed red-gold as he worked the keys.

His profile made a black hole against the candlelight washing off the wall behind him. His neck craned out to the sax, his throat a straight line from his tie knot to the tip of his chin, curling up to his lips over the mouthpiece. A speck of firelight danced in his eye.

Midori and Jake in Soweto, 1997 -- friends for life.

The sax sagged from his lips past his fondling fingers to rest its bottom on the carpet between his feet. The horn had a yellow rag stuffed down its throat, "otherwise I will blow the candle out", and as he played the rag flapped out like a tongue over the horn's huge brass Adam's apple.

Jake's playing was liquid -- ripples and waves with crests curling over high notes and splashing down again, ebbing and flowing.

He muffed a note, spluttered and stopped, indignant. "That was a brand new reed!"

He laid down the sax, stood up and moved to the sax case on the floor nearby. Stooping, he opened it, took out a small bottle of lubricating oil for the keys, a neck strap, three library books on astronomy, an Instamatic camera, part of a telescope stand, a witchdoctor's love potion (pink powder wrapped in newspaper), a design for an antigravity machine sketched in pencil on a postcard, sheet music, odd photographs, some papers and forms, and a cigarette packet containing five broken mouthpiece reeds -- but no new reeds.

"Jeewiz!" Irritated, he threw packet and reeds into the fire and watched them burn.

"Here, Jake." I passed him the bottle of illicit wine we'd bought from the old black witch who ran a shebeen in her shack across the veld. He took the bottle and raised it to his lips for a long draught. He turned to

Forbidden fruit

Full story

No sugar

Full story

Treasure in a bowl of porridge

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Hong Kong and Southeast Asia
-- Journalist follows his nose

Nutrient Starved Soils Lead To Nutrient Starved People

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Cecil Rajendra
A Third World Poet and His Works

Full story

the firelight and started reading the week-old newspaper page the bottle had been wrapped in.

He found two stories that interested him. The first concerned the death of a Zionist Christian Church bishop, Joseph Lekganyane, prophet messiah to millions of devout blacks, and Jake's brother-in-law, in a complicated sort of way. The second was about a white Eastern Transvaal farmer named Eliastam who it was reported had built a school for the children of his black labourers. Jake showed it to me, I read it and looked at the photograph, and then he told me a tale about the philanthropic Mr. Eliastam. He said:

It was a winter morning at home in Dark City -- Alexandra Township. We had only one room there: bedroom, kitchen, lounge -- everything in one room. We were asleep -- it was very early in the morning. Then the police came -- pass raid! Black cops, black like us -- they didn't even knock politely, they just came and kicked the door in. And they didn't ask questions, ai, man, they beat us with their sticks instead.

I tried to run away -- I was screaming, Jeewiz -- but they took us away, me and my brother Elias. I told them I was a recording artist: the record company gave us papers for the police, saying: To Whom It May Concern -- phone us immediately if there is any difficulty concerning myself, the bearer. The police didn't care about the paper, they just tore it up.

My mother, she tried by all her means to help us. That morning she went to the Wynberg Court, where we were. She wanted to pay for us, I and Elias. But they said no. There was no fine.

The offence? The offence was failing to produce a pass. I couldn't get a pass. I was young at the time, they wouldn't give me one. I went to the pass office three times with my mother, but I was too young for a pass, they said, so they wouldn't give me one. Then they arrest me for not having one.

And Elias -- well, he's my elder brother, but I must say that he was just an ignorant somebody-or-other. He didn't have time for the pass office -- he didn't like to think about standing in the long queue there. He'd rather go and wear nice clothes, walking round the streets for all the girls to see him, walking along playing a pennywhistle for the dolls. He had plenty of girls, that boy -- even now, that guy's got girls all over... But he didn't have a pass.

At the court afterwards they sold us. Like at an auction -- money for labour. They sold us to Mr. Eliastam. He bought a lot of us there that day -- thirty, maybe. They put us all in a big lorry, an open truck, guarded by people with spears.

I remember somebody tried to escape. He jumped off the lorry into the road and he fell -- he tried to dodge, but the lorry was speeding. He timed wrong and he fell. I saw him shaking and writhing on the ground, and I thought he was dying, sure, he was dying. Nobody knows what

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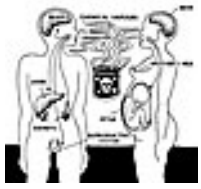

Mo man tai ('No problem')
-- "Write whatever you like" -- a weekly column

happened to him. They just left him there. If they stop the truck everybody's going to get off and run away from them, so they just left him there to die in the road.

Now the guards begin to be very aggressive. Those guys with their spears, looking at us with warning eyes, very mean eyes... We'll spear you -- they were thinking about it, thinking about doing it to us.

In the end we came to this farm, well guarded with gates and a big fence, and deep inside the farm a huge garage, like an aeroplane shed, with big doors.

They pushed us inside the garage: three of them this side, three that side, they push the doors closed, locking the outside.

Man, it's a July night, the middle of winter -- it's cold. But they start to strip us, take off our clothing, trousers too, and they give us sacks -- one sack to wear, one sack to sleep on. No blankets, you just take this sack and you sleep right on the cement floor, and there are big gaping holes in the roof. It's cold, the wind gets in, everything gets in. So we sort of sleep, in the sacks on the cement.

And at four o'clock in the morning -- sticks! Wake up! Wake up and work! Wake up! Wake up and work! Four o'clock! We're like beasts in our sacks -- others haven't even got shoes. They gave me shoes, but bi-i-ig ones, army boots -- much too big. And a can, not even a flask.

They take us in a tractor, far -- two hours in the tractor. Six o'clock, cold, no food, we work, loading mealie corn, and it's so hard, it's so cold. Icicles on the mealie corn, and what about your fingers? No gloves.

And I'm a slow man. It's in everything I do. I can't hurry -- if I try to make things faster then I just mess it up. So they chase me -- dragging a 190-pound bag, dragging it and carrying it to the tractor. After filling it up. You have to be fast about it, otherwise you get it -- you get a very big stick right in the middle of your back.

Every day work -- Saturday, Sunday too. Such a place: work, bad food, no clothes, terrible cold, no sleep. After three weeks I couldn't take it anymore. We form a scheme, I and my brother. We are going to run away.

I start to climb -- this big door has bars, sort of girders. I go up -- I'm a cat. I went right to the top. I start to walk, to move by the roof poles, one by one, until I reach the window. Slowly, quietly, I break the glass, and I come down again. And then I made a mistake -- I fell asleep.

We were very tired. Waiting for the right time, I fell asleep, and Elias too. And then these guys climbed up there and jumped out -- they didn't know what was underneath, they just jumped. There were some chickens there, they landed on top of them -- qwak qwaak qwaak! And the dogs started, wow wow! The guards chased after them, but they were too late to catch them, they ran away -- seven or eight of them.

The guards came back, opened up the big doors. They were like madmen -- the farmer was there, he was worse than them. They beat us with whips, but everybody kept quiet, nobody said anything.

They beat us more, and then this Venda guy, he told them everything, he said he saw me climb. And then the farmer, this Eliastam,

Swag bag
Death of a Toyota

Full story

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he tried to kill me -- he hit me, kicked me, tried to drop me down, but he couldn't. He tried and he tried, but I still stood up.

He called one of the guards, they put handcuffs on my hands, behind my back. He beat me again -- I lost my balance with the handcuffs, I fell to the ground. Then he was on top of me, on the ground, his hands on my throat, choking me -- he's shouting all the time, I must tell him the truth, he wants the truth, where are they, the labourers who ran away, what about his crops, where are they? Ai, man, he hit me that guy, he choked me, kicked me on the ground there, right into another dimension for the whole night.

I lay there all night, and everybody thought I was dead. Because there was no heartbeat in me -- but my brains were still working: only the heartbeat was so soft it wasn't there.

I was not unconscious because I sort of saw myself, sort of dreaming myself, I think. It was just like a dream: I was seeing myself in it. I don't know for how many hours, but I was still there the following morning, lying there dead, handcuffed on the cement... until something brought me back, just when the sun was rising.

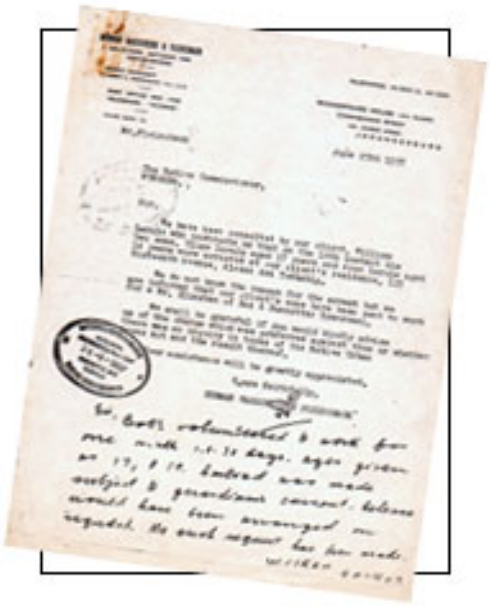
I could feel myself again, I heard that farmer saying: Ja, nou is hy reg -- Yes, now he's alright. I saw people coming to me, many people. My brother, I saw he was angry. He told me afterwards they wanted to bury me there on the farm, and he was fighting them, he told them: I will take my brother home, it is my brother -- otherwise kill me too -- you will never bury him in a field...

They asked me my name -- but I couldn't answer them, I didn't know my name. I didn't know myself... Then I remembered: My name is Jake. Then they took my hands, took the handcuffs off me -- still the handcuffs, on the cement! And they left me alone that day.

That farmer, the same day that he killed me, he got a letter from my mother's lawyer, Mr. Joel Carlson. They were so afraid of him at Wynberg Courts, that man, and so was the farmer. They started to treat me nicely. They didn't want me to work anymore. They let Elias and me out of that aeroplane garage then. We left the prisoners, we went to live in the compound with the paid workers -- a taste of freedom, good food, warm, our clothes back, getting water when we wanted to wash... The rest of the prisoners stayed in the garage, including that Venda. But we lived good for a whole month. Then I went home.

But that man Eliastam, when he beat me, he did something to my throat, my voice -- he made my voice like this when he strangled me. It was already deep, but not like this -- so deep, growlly, hor-hor. I thought he broke it, but no, my voice is famous -- all over they know me: Jake, the man from the stars with the big voice. They know my songs... and now, all the bands have groaners who try to copy my voice, but they can't -- it wasn't them who died that day, it was me, and there were no groaners before then.'

Jake had kept the letter lawyer Carlson (later famous for his courageous enquiries into the deaths of political prisoners killed in police detention) had written to the "Native Commissioner" at Wynberg.



Herman Wasserzug and Fleischak
Shakespeare House
Commissioner Street
JOHANNESBURG
June 25th 1957

The Native Commissioner,
WYNBERG.

Sir,

We have been consulted by our client, William Lerula who instructs us that on the 14th instant his sons, Elias Lerula aged 17 years and Jacob Lerula aged 14 years were arrested at our client's residence, 123 Sixteenth Avenue, Alexandria Township.

We do not know the reason for the arrest but we are informed that our client's sons have been sent to work for a Mr. Eliastam of Box 6 Dunnottar Transvaal.

We shall be grateful if you would kindly advise us of the charge which was preferred against them or whether there was in inquiry in terms of the Native Urban Areas Act and the result thereof.

Yours faithfully,
Herman Wasserzug and Fleischak.
Joel Carlson
[Signed]

The letter was rubber stamped by the Native Commissioner, Alexandra Township, P.O. Box Bergvlei, 25-6-1957, and at the bottom was scrawled the magistrate's reply:

Sir,

Both volunteered to work for one month i.e. 30 days. Ages given as 17 and 19. Contract was made subject to guardian's consent. Release would have been arranged on request. No such request has been made.

Wilken 40-1247"

... "E Bra Keith..."

"I thought you'd fallen asleep, Jake."

"No, I am awake now," he yawned. "That story reminds me -- can

you fix my pass?"

"What's wrong with it?"

"No, nothing's wrong with it -- it just needs you to sign it, asseblief baas (please boss)."

"Baas? What do you mean, baas?"

He laughed: "It is true, you are my baas."

My music promotion business paid Jake a retainer of R200 a month -- not too much but all I could squeeze out of the accountant, and Jake didn't have to do anything for it. Which made me his white boss. Your white boss has to sign your pass every month otherwise you lose your "right" to be in an urban area and are "endorsed out" to the tribal lands -- even if you were born in the city and had no idea which tribe you came from. This is one of the great evils of racist South Africa.

"Give it here then. Have you got a pen?"

"Yes." He took a pen from his jacket and a wallet from his back pocket. He opened the wallet, removed the pass book, opened it and handed it to me with the pen. I looked at it.

"Whose signature is this for last month?"

"That's Louis Peterson, at the record company."

"But Louis can't sign your pass, he's a black."

"No, he's a Cape Coloured."

"Oh, so he is." Mixed-race Cape Coloureds (and Asians) are "second-class citizens", blacks are only "third-class citizens". I suppose it all made some sort of insane sense to somebody or other, but it never made any sense to me.

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Zebra Crossing

-- On the wrong side of South Africa's racial divide

by Keith Addison

South Africa, 1974

Stories by Keith Addison

Zebra Crossing
-- On the wrong side of South Africa's racial divide.

Kwela Jake
Sold into slavery
Mamelodi
Finding Tom Hark
Return of the Big Voice
Brother Jake

Tai Long Wan
-- Tales from a vanishing village

Introduction

Full story

Tea money

Full story

Mamelodi

A VIOLENT thump on the back gave me a shock and almost winded me. "Hi!" a black voice said.

I swung round to see a short, stocky young wildman with bright eyes, a jutting out beard, knotted hair and a brilliant smile, wearing sandals, a tee-shirt and the most faded, patched, tattiest denims I'd ever seen.

"Hi, Lefifi Tladi."

"How're you?" he asked.

"I've got a sore back." He laughed. "And how're you?" I asked.

"Umm... partly powerful."

"Only partly? Didn't feel like it to me. Are we the only ones here?"

"No, come and meet my friends, they're sitting on the grass over there behind the stage."

We walked together towards the stage. He swept his arm around: "Look at all this -- this stadium, those seats, all this space: all empty."

"D'you think it'll stay that way?"

He looked at me: "Haven't you heard about the soccer?"

"The Callies-Pirates game?"

"Yes, it's off."

"Really? Good, then we'll have a good crowd." The big game would have been competition to the jazz spectacular I'd planned for the people of Pretoria that day.

"We'll have a big crowd of disappointed soccer fans," Lefifi said, "and they'll all be drunk."

I groaned. "I suppose you're right."

"Sure. Hey, who put all that junk on the stage?"

Someone had pasted dayglo stickers reading "Ellis furniture makes your home smarter" all over the sides of the stage.

"The sponsors," I said. "They think their name is the most beautiful thing in the world."

"Why don't we tear it down? It looks shit."

"Aah... let them have their way." But later I noticed the stickers were gone.

We passed the stage and joined Lefifi's friends, two men and three

Forbidden fruit

Full story

No sugar

Full story

Treasure in a bowl of porridge

Full story

Hong Kong and Southeast Asia
-- Journalist follows his nose

Nutrient Starved Soils Lead To Nutrient Starved People

Full story

Cecil Rajendra
A Third World Poet and His Works

Full story

women relaxing on the grass with some wine and a bottleneck of dagga. We sat down beside them.

I thought of what Lefifi had said about the big game. At least we'd make some money, but soccer fans deprived of their weekend clash would certainly not stay sober for long. Great: twenty thousand drunk blacks and one whitey -- me.

Half an hour later we were still the only people there. Then a two-tonner loaded with big loudspeaker boxes clattered into the stadium, stopped at the stage and two white longhairs jumped out -- the sound men. Things looked up -- twenty thousand drunk blacks and me and Terry and Stan.

The rest of Dashiki, Lefifi's band, arrived and he ran off to unload his drums. I joined Terry and Stan.

"Sorry we're late."

"Everyone's late, as you can see."

"Oh, that's allright then. By the way, have you noticed this railing? It's no good. It's only supported at one end, and it'll fall on top of us when these people start leaning on it."

I decided not to tell them about the soccer. "Why don't you set up at the back of the stage?"

"Can't hear anything there. Impossible to balance properly. I must tell you we've done a show here before -- Mamelodi is a heavy scene, it's not like Jabulani."

They didn't need telling after all.

My partner, promoter Ray Nkwe, arrived. The crew of black office messengers that the ad agency (our other partner, so to speak) had arranged would handle the gate arrived and set up in the box offices.

The caterers arrived -- a charity group I'd given the concession to -- and made me breakfast of fried dumplings and coffee.

The Jazz Ministers arrived, with their 13-year-old pianist Nomvula Ndlazilwane: "She had to get permission from school to miss a hockey match this afternoon." And the Clan, and the Jazz Preachers, wearing purple and yellow satin -- "Baby, ain't I BEAUTiful?" And Batsumi, a tribal jazz band with a witch dancer, led by flautist Tom Masemola, an ex-kwela kid like Jake.

People arrived. Small groups picnicked on the grass, the stand began to fill.

Terry got one amp working and played Santana at 500 watts, people swayed to the music.

Soon everything was ready. About a thousand people were there, we were an hour and a half late, but nobody wanted to play.

Leave the farmers alone
Book review of "Indigenous Agricultural Revolution -- Ecology and Food Production in West Africa", by Paul Richards

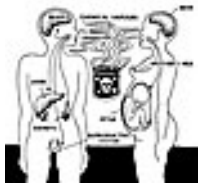
Full story

A timeless art
Some of the finest objects ever made

Full story

Health hazards dog progress in electronics sector
The dark side of electronics -- what happens to the health of workers on the production line

Full story



Mo man tai ('No problem')
-- "Write whatever you like" -- a weekly column

"None of them wants to play first," said Ray.

"So?"

"Well then, they can all play first," he said. "You -- you and you -- "

He chose one or two from each band and they took the stage. The small crowd cheered. The band played Coltrane, and Miles Davis, and then Coleman Hawkins, and combined quite well considering, according to Jeff Mthakathe, who was standing next to me in front of the stage listening.

Standing that close, we had to shout in each other's ear to be heard above the music. This entailed a series of crouches and cranings, because, though I'm six foot one, Jeff was six foot eight. Watching him disentwine his elongated frame from the equipment in the back of Dashiki's van where he'd been sitting was a sight on its own.

Most whites were completely unprepared for a huge black detribalised apparition like Jeff. As they dithered in dismay, he made them do astonishing things for him, which made him good at his job -- he worked for the US Embassy's cultural section, making life easier for black artists, sculptors, writers, poets, musicians. The Dashiki workshop was one of his cares.

Jeff nudged me on the shoulder with his elbow. I craned and he crouched.

"Hey man, who're those white bosses just came in over there, they friends of your's?"

I looked: "Ellis bosses, the sponsors -- not friends."

I went to meet them: Koosie the director, an Afrikaner, short and plump and sleek and smooth and elaborately casual in blue; Colin the promotions manager, tall, thin and craggy in a big flapping Afro shirt and denims; their tame urban Bantu, Mike, the head office chief salesman, camp and dandy and ingratiating.

Sheets of white flame lash from the sky at the world and scorch the oceans down to dry beds of cracked rock.

Machines smash the mountains, fill the world's holes with the rubble, pack down the surface evenly level, sandpaper it smooth as a billiard ball.

Other machines cover it with dayglo red, yellow, orange, pink and green linoleum squares a yard wide.

More machines lay an evenly distributed 63% of the world with 2ft-square purple stickers printed with big black letters:

ELLIS FURNITURE SHOW
COME IN AND CATCH AN ELLIS BARGAIN
MAKE YOUR HOME SMARTER WITH ELLIS

Field research has shown that higher than 63% environmental message exposure tends to produce sensory seizure even in lobotomised consumers.

Swag bag
Death of a Toyota

Full story

Curriculum Vitae

The machines depart.

Five hundred million black workers appear, and then a million white supervisors carrying rolls of plans and wearing yellow plastic site helmets. The blacks work and the whites supervise.

They assemble an intricate global web of three-foot-high orange and green dayglo plastic partitions bearing the same slogans as the floor stickers, forming walkways cunningly leading to strategically placed hi-thru-flo malls, in which they position tastefully displayed bedroom suites, lounge suites, diningroom suites, kitchen units, appliances, radiogrammes and luxury items, all made of pure hi-gloss plastigold mirrortrim.

Between the malls they erect prefabricated observation/co-ordination suites made of extruded aluminium, chromium, perspex, plastic, one-way glass and air-conditioning, five-sided so as to front on five malls at once.

Inside they install English wall-to-wall carpeting, Danish imbuia low-line desks and easy chairs, plate glass and chromium tubing coffee tables, Swedish modular wall furniture with cocktail cabinets, hidden telephones and tickertapes, display sections with objets d'art, stereo and TV, bookshelves with books on finance and management, and computer co-cordinated sales progress visual display units.

Workers and supervisors depart. The supervisors return in neat well-groomed executive suits. They enter the observation suites and make themselves comfortable. They are all similar to Koosie and Colin.

Beautiful Miss World personal assistants with hairdos and makeup and cocktail dresses appear, pour the executives Napoleon brandies, turn on the stereo, adjust to a discreet volume, hover.

Koosie talks of his esoteric government contacts and the special pressures he can bring to bear on the situation, of how he made it the hard way with nothing but grit and a dauntless determination to get to the top. "You've got to be tough, you've got to be ruthless."

Colin listens admiringly, but half his mind thinks of dinner tonight, and that secretary, and later...

Outside two Mikes appear in each mall, wearing beautifully tailored Italian suits, handmade silk shirts, wide ties with colourful bold patterns, powder-blue silk sticking from breast pockets, soft leather shoes...

Piped Ellis messages intersperse with snatches of bland matinee music from loudspeakers concealed in the partitions.

The workers reappear wearing uniform consumer smocks and lobotomised smiles. They mill in endless streams through the walkways, stopping in each mall to buybuybuybuybuybuybuybuybuybuybuybuy.

... "I expected a bigger crowd than this by now," said Koosie.

"Be patient, we've only just started."

"Why so late?"

"It doesn't matter, everybody's late."

He looked at me quizzically. I said for him: "Blacks are always late."

He laughed: "Don't I know it -- it costs me thousands." Mike squealed with laughter.

Colin said: "We've brought Mike along to do a bit of compering for us."

"I've got a compere," I said. "Sol Rachilo -- he's well-known and popular, and I've paid him already."

"Yes, that's fine -- but I'm sure there'll be a minute here and there for Mike to say a few words, we'd like the people to know about a few special offers we have in store for them."

I paused... but they paid the bill: "I suppose that's alright," I said. I decided to tell them about the soccer.

"That's good," said Colin, as I had, "we'll have a big crowd then." I explained further. They became serious.

"D'you think it's safe?"

"I suppose so. There are supposed to be some police here for crowd control, but they haven't turned up yet."

"White police?" asked Koosie.

"No, blacks."

They looked worried. They turned to Mike. He thought it would be dangerous for them to stay too long.

"I'm sure it'll be alright," I said.

"Well, we'll stay for awhile and see," said Koosie.

I left them in order to attend to an urgent pretext. Half an hour later someone threw a beercan at them. Quite a few others thought it was a good idea and threw some more. Ray rescued them and drove them to safety in his van and they left Mamelodi -- but Mike stayed behind to lay The Message on the people.

At the agency the following Monday I was told by bossman Jack Hines: "Last time we all nearly got arrested" (Major van der Heever had made a deep impression) "and this time the crowd stones the client."

"Beercans," I said.

"What?"

"Not stones, beercans."

Lefifi Tladi was arrested by the security police soon after the riots started in Soweto on June 16, 1976. It made me sad and angry, but it didn't surprise me much. He was an obvious target, a focus for the growth of black consciousness.

After Ray's consortium band had raised the curtain, Dashiki took over, playing on their home ground.

The crowd had swelled, and as soon as Lefifi appeared onstage

carrying one of his drums a forest of clenched fists shot up in the Black Power salute and they roared: "JO-MO! JO-MO!" The people had nicknamed him after Kenya's independence hero Jomo Kenyatta.

He carried his drums on one by one -- four wooden drums four feet high, carved in Ovamboland from tree trunks, embellished with witch mask faces. He set them up and Terry positioned and adjusted the microphones for them and for Lefifi to sing, another for the malombo guitar and another for the flute. Stan balanced the mikes.

Lefifi beat a multipitched roll on all four drums and yelled into the mike: "This is the spirit of our forefathers!"

"JO-MO!" they roared. The drum roll swelled to bursting and then swung into an Afro rhythm, the flute and guitar fell in and the crowd started to dance. Jomo sang and they loved him, they couldn't have enough.

Hearing the music and all the yelling, people stopped hanging about outside, paid their money at the gate and flooded into the grounds to converge on the stage. By the time Dashiki finished their set 45 minutes later, there were about 12,000 people listening to them. They roared for Jomo to come back, but we had no lights and no night permit, and there was no time for encores if each band was to play before sundown.

I was walking away from the stage to see what was happening at the gate when I stopped to listen to a message from our sponsors. Mike was at the mike onstage, smile turned to Full.

"Hello, friends and neighbours, I'm your friendly Ellis comfort advisor, and I'd like you all to give a big hand to that fabulous band you've just heard -- Dashiki!"

There was a ragged cheer.

"And let me tell you -- do you know why they play so well? Do you? Well I'll tell you why -- it's because they live in Ellis luxury, that's why!"

There were some jeers and cackles.

"Yes folks, these guys know what's good for them -- their homes are furnished with sheer comfort from Ellis, the company that brings you this great show here today..."

He squawked with fright as a beercan thudded onto the planks at his feet. He peered out fearfully at the crowd, smile gone. Came another, he ducked, more, and he fled to loud jeers, laughter and catcalls, which turned to applause when Sol took the mike and announced that the guys in satin setting up and plugging in were "the Jazz Preachers, being paid good money to preach to the converted".

I stayed to hear their first number, beaty mainstream jazz with lots of dash. I felt a pat on the shoulder --

Tommy Masemola of Batsumi had joined me.

"Tom," I said, "why is that young saxplayer of your's climbing onstage? It's not his turn."

"Oh God," Tom groaned, "just look at him."

Temba has very drunk. His stabilisers couldn't handle the high tide and read "TILT". He reeled up the steps on rubber legs. He was a mess -- dirty shirt torn and twisted up, buttons in the wrong holes, no socks, only one shoe, his belt screwed through only half the tabs in his baggy grey flannels. He carried a silver tenor sax on the tag round his neck.

The Soul Jazzmen at work at Mamelodi.

He made it to the top of the steps. He peered about, set a bearing on the nearest mike and sailed towards it. He reached the mike, stopped, turned, positioned himself in front of it and heaved the sax up towards his face. But the momentum thus generated threw him off balance and he staggered back out of control, reeled forward in overreaction, finally lurched himself stable. He lifted the sax and blew... but ridiculous noises came out the end: a raucous out-of-key screech that didn't fit anywhere and went nowhere.

The Preachers, laying down their brass sermon all the while, didn't know what to do. They began to make fun of him.

"He was drunk this morning early when we called at his home to pick him up," said Tom. "So I fired him. It's not the first time, he does it often. We're fed up with him. Now he's come here under his own steam, and he's had more to drink on the way..."

People in the crowd were laughing at Temba now, but he took it as acclaim and bowed grotesquely. The whole crowd laughed. He stopped, glared at them. He waved his arms, sax dangling, shouting at the mike. Tom laughed, everyone laughed at what he said, but I couldn't understand it, he was speaking Zulu.

"What's he saying?"

"He's swearing at everyone."

The more he swore the louder they laughed and the angrier he got so the more he swore, until he was roaring in an inarticulate fury. Suddenly he stopped, grabbed the sax and began to play the same drunken noises.

Ray Nkwe was onstage. He rushed at Temba and grabbed him by the arm and shirt, jerking him away from the mike, but the mike picked up Ray's voice:

"You drunken tsotsi delinquent -- what do you think you're doing -- you've got no respect -- "

Winston "Mankunku" Ngozi, ace sax player with the The Cliffs.

Ray dragged him offstage and down the steps, Temba stumbling all the way, and then Ray gave him a mighty shove and he went flying, miraculously keeping his feet. They drew a big laugh and a round of applause. The Preachers hadn't missed a beat.

Temba wasn't finished yet. He fell straight into an argument with five young guys, all bigger and stronger than him.

At first they refused to take him seriously and tried to laugh him off, but then he threw a wild punch at one of them with one arm and swung the sax with the other. The haymaker went wild and they wrested the sax from him easily. He tried another punch. They grabbed him and pinned his arms, but with surprising strength he shook them off and started punching again.

Then they climbed in meaning business, and he vanished inside a mass of pumping arms and legs, which soon cleared, leaving Temba half-stunned on the ground with a coating of light brown dust and bits of dried grass all over his clothes, his face, in his hair. His saxophone lay nearby, without the mouthpiece.

He staggered to his feet, aparently not hurt, and undaunted. He picked up the sax and trailed off, dragging the sax behind him in the dust, leaving behind the remains of his shirt and his other shoe.

Tom watched sadly. Still Temba wasn't finished. He lurched into a pretty girl, leered some beery suggestion right in her face. She laughed and pushed him away, but her man didn't laugh, he took offence. He also took the saxophone in both hands, lifted it high and smashed it down to the ground almost on Temba's foot. The sax buckled and half the keys flew off. Temba didn't move.

The man politely handed him the twisted silver remains. Temba took it and stared at it dumbly as the couple moved on. Then he dropped it and went off carelessly to look for another bottle.

"That's that," said Tom. "Well, he's in good company. Half our best talent goes that way. He could have been good... now he's finished. Where will he get another saxophone?"

"Here's Ray."

"Au, Tom, that tsotsi of your's..."

"No, he is not my tsotsi anymore, I fired him this morning. I didn't bring him here. But I'm sorry."

"No, never mind. Keith we need some police to control this crowd."

"I arranged for two contingents to be here, but they haven't turned

up. I'd better go and fetch them."

"Yes, look at the barrier fence." A few thousand people were putting their weight on it, and it was leaning over crazily, not taking the strain well. Terry and Stan crouched behind it over their consoles, looking tense, also not taking the strain too well.

I went to look for Sol Rachilo, and found him behind the stage. I asked him to clear the people from the fence when the number ended. It ended and he sprang up onto the stage and took the mike.

"Listen to me, you folks there on the fence -- yes, that's right, you there -- if you push any harder you're going to squash the sound engineer and smash all his equipment, and then you won't be able to hear anything, so get back please -- GET BACK FROM THAT FENCE PLEASE -- THE PREACHERS WON'T PLAY TILL YOU GET OFF THAT FENCE... yes, that's right people, move back..."

Gradually they moved back, but in the process a small eddy of fans washed over the steps, clogging them.

Three bright-eyes urchins found a good seat on top of the piano, but they didn't stay there long -- a big double bass player lifted all three off with one swoop of his arm and dropped them six feet to the trampled grass below. They landed on all fours like cats, without bumping each other, and sprang away, shouting with laughter.

I resumed my stroll to the gate. I'd moved about 20 yards when I found myself staring at three trendy townships lasses leaning against a van drinking beer. I was staring especially at one of them -- tall and shapely in a beige kaftan, she had fine features and a great smile, and an amazing wig: blond hair spilled over her chocolate shoulders down to her waist.

She caught me staring and smiled. "Hi, do you want some of my beer?"

I walked over. "Just a sip." I sipped, they giggled.

"Take a photograph of us?" she asked.

"Oh, please?" they begged.

"Sure," I said, and backed off to focus while they struck a zany, tipsy pose. I backed off some more, into the back of a big man wearing flannels and a dirty white vest. We both swung round. His face was two feet away, but his enormous belly was right against me.

"Hey, man, who're you pushing there?" he said.

"Sorry," I replied, "I didn't see you."

His eyes widened. "You didn't see ME?" He put his arms round his huge gut and shook it like a big jelly. "You didn't see THIS?"

I was embarrassed. "No, I was walking backwards."

"Backwards?" He shook his head. "You mustn't walk backwards man, you must walk FORWARDS, otherwise you can't see where you're going, don't you know that?" And then you bump into people. Now you just take a photograph of this belly of mine." He wobbled it again.

So I had to take one of him too, while the three girls shrieked with laughter at me, and I could feel myself flushing to the roots. I took some more shots and said goodbye.

"Goodbye," the girls trilled, still giggling.

I hadn't gone far when a flamboyant young guy stepped in front of me, puffing out his chest.

"What you doing here, man?"

"Listening to music, taking photographs."

"Take a photograph of me then." He struck a ridiculous, mocking pose.

"No -- you're too ugly."

He'd never heard anything so preposterous. He roared with laughter, thumped his chest: "UGly? I'm beautiful, man, I'm BEAUTiful, you hear?" He moved on still laughing.

By the time I'd survived the three men who called me "baas" (boss) and added that it was short for bastard, the two Black Power kids who asked me when I was leaving -- "No, not Mamelodi -- South Africa", several other heavies, some drunk and amorous ladies and scores of demands that I take people's photographs, and had finally reached the gate, I was feeling a bit stretched.

There were two stolid black cops on guard at the gate, both wearing heavy forces-issue overcoats in the hot sunshine -- the only cops in the ground, and I'd been promised dozens.

"We're in control here, baas," they assured me. But in fact they were standing there like a couple of dummies without any clue about the racket that was going on right under their noses. I didn't see it either, but those concerned had been watching out for me, and everything was clean by the time I got there.

The arrangements were primitive. Instead of turnstyles with counters, there was a big corrugated iron gate. Four of the agency men were more or less keeping the stream on a one-by-one basis, tearing each ticket and giving back half. It wouldn't get any busier than this, and they seemed to be coping. I went to my car and drove to the back gate, which was barred and chained. A guard unlocked it and I left the stadium. I spent the next hour searching for and arguing with policemen, till I'd raised a force of about twenty. I followed their van back to the stadium.

Inside again, a face appeared at my window and a deep, familiar growl said; "Hi, brother!"

"Jake, hi!"

"I've been looking for you everywhere, man!"

"Why, what's going on?" My favourite question.

"No, bad things are going on here, terrible! You see, the way it is..."

"Let me park the car first."

"Yes, park the car." He climbed in behind me and went on talking. "You see, those bums from the agency, they are robbing you badly!"

"Yes? How?"

"The ones at the gate, they are keeping the tickets, not tearing them and giving back half, and then they send them outside again to the queues at the ticket offices, and sell them again there, and again also maybe -- as often as they like. Three for them, one for you, maybe."

"That's very greedy," I said.

"Very very greedy. And also there are three holes in the fences where the people are coming in. You must tell those police you brought to send guards to the holes." We were out of the car now and moving towards the main gate.

"They'll just stand at the holes and charge half price," I said. "But yes, I'll tell them." We caught up with the police, and

This happy picture at one of our concerts was published on 4 June 1974 by The Vaderland, an Afrikaans-language pro-government daily newspaper, under the headline: "Young whites take Soweto by the horns -- Piebald dancing... even on Sundays".

"When things are dull in the city," went the story, "white girls and boys go to Soweto to let their hair down to the beat of the soul rhythms of Africa.

"Such 'jive sessions' are a kaleidoscope of contrasts: blonde hair in long strings, sweating black faces; white pulses fluttering in time to the throb of the music, with black bodies dancing along...

"It's the music that calls them, say the whites.

"The rhythm that throbs in Soweto is urgent: it demands complete abandonment, and the young whites love to give themselves to it.

"Most city people only hear snatches of this wild throbbing at those record stores which sell Bantu music. But it's at the 'sessions' that the thing enslaves them.

"Maybe it's when the wildly screaming music is echoed in the wild dancing of thousands of black and brown bodies that the attraction reached into peak..."

And so on.

A quarter of a million Afrikaners saw the pictures, read the story, and many of them wrote outraged letters to editors, and to Prime Minister John Vorster, who was one of the newspaper's directors.

Jake told them in Sotho. Two went to each hole.

"How did you find all this out?" I asked him.

"Friends saw and called me, then I saw too."

"How long have you been here?"

"About half an hour."

"That was pretty quick, Jake, thankyou."

Someone ran up, caught at my sleeve: Ray's teenager son. "My father wants you at the stage."

"Oh... will you tell him I'll come as soon as I can, in four minutes?"

"Yes." He ran away.

We reached the main gate. As expected, everything was as it should be. Tickets were being torn and halves handed back. I couldn't see anyone plying the queues outside.

A furious Vorster commissioned a special police inquiry to investigate this illegal racial mixing -- exactly what apartheid was supposed to prevent.

We had our "story" prepared, witnesses primed, and we managed to spin the cops. They recommended to Vorster that his newspaper be censured for irresponsible reporting.

In fact the newspaper was right, that was exactly what was happening. We were lucky not to get ourselves jailed -- plenty of others were, or worse.

The two ticket takers showed me thick wads of ticket halves. Jake and I went looking for David, their main man, and found him in the second box office. I went inside.

It was dark, hot and smelly, and there was barely room for the two of us behind the counter. I closed the door behind me.

"How's it going in here?"

"Hot work. I'm relieving this man while he's relieving himself."

He laughed. I looked outside through the bars. It was a hot dusty scene of sunlight and shadow, and hot dusky faces in the shadows, with one big face in the middle, a hand pushing a note across the scratched, greasy counter towards me, and the bars striping everything black. David took the money and gave the man a ticket, and the next, and the next. I didn't say anything. At length he looked up at me and for a second our gazes caught and held, then he looked back at the counter.

"How many people do you think there are inside now?" I asked.

"I can't say offhand. More than ten thousand." He didn't stop working.

"I'd say more like fifteen thousand."

"Possibly. They tell you about the holes in the fences?"

"Someone told me."

"I sent him."

"I don't think so."

"Many people came in. We could do nothing. We are all too busy here. I asked the police to go, but they said they had been told to stand here at the gate."

"Not more than a thousand got in that way," I said. We both knew it was more than that. "There's a car going to Johannesburg soon. Will you take a ticket count and sub-total the cash so that they can take it with them? I'll take the rest from you tonight. Just leave yourself as much

now as you started with -- R50."

"I can have it ready in about 10 minutes -- most of the tickets are already in hundreds, and the money too."

There was no car going to Johannesburg, but 10 minutes later I was walking with Jake, a sack full of money in my hand, through a mob of drunks towards my car. We reached it without trouble, and I drove round the back of the stand and then over the grass to behind the stage where the musician's vans were grouped.

I was very pleased I'd driven there and not walked. Everyone seemed to be thunderously drunk. Several tried to kamikaze the car. The uproar was awesome, and I had a keen headache.

"Let's sit in here for a while with the doors locked," I said.

He laughed. "Alright brother."

But then there was a rapping on the window. Ray. That's right, he'd wanted me. I opened the back door for him, he got in. I told him what had happened and he sent some of his people along to watch the agency men.

"Are Terry and Stan still alive?" I asked.

"Yes, but the crowd is terrible there on the rails. There are three police there and two more at each end of the stage, but they can't do much."

"By the way, what did you want me for?"

"Ah -- the cheques, to pay the bands."

I gave them to him and he got out and hurried away. We smoked for awhile, and decided to go see the sights.

The noise was monstrous. The music was very loud in order to rise above the crowd -- at least half of them at any moment were shouting at each other as loud as they could, and blacks have got huge voices for yelling across valleys with.

Jake met some friends and stopped to chat. I wandered on alone, feeling bludgeoned by the racket. Suddenly I felt a thump on the back -- on the same spot, but gentler this time. Lefifi, grinning at me. He shouted something, but I didn't catch it and shook my head, frowning. I crouched and he craned to shout in my ear: "Hi! Can we play again?"

"No!" I bawled back.

"Why?"

"There's only an hour left and two bands to play!"

"What?"

"ONE HOUR, TWO BANDS!"

"But it's our home crowd!"

"What?"

"HOME CROWD!"

"Sorry, no!"

"But..."

I bawled in his ear: "If you can persuade one of the other bands to stand down for you, yes -- otherwise no!"

He nodded, grinned wryly, slapped me on the shoulder and went off

to try.

I spied Jeff's head and shoulders in clear air above the mass of people in front of the stage and for some demented reason I decided to join him. I started to scramble through the crowd.

I felt someone tug at my arm and suddenly a fury of accumulated abrasion swept through me and I had to fight not to turn and smash into whoever it was, which would surely have been the death of me. I turned slowly to face a sweaty head a foot from mine, wreathing me in reeking fumes. It was a certain pianist, now very drunk.

He shouted, but I didn't hear. He yelled in my ear -- more fumes -- and it was the same question: "Can we play again?"

"No!"

"Why?"

"No time!"

"What?" Still the fumes.

"NO TIME!"

"But just one number!"

My turn: "What?"

"What?" That was cheating!

"No!"

"But just one..."

"NO!"

"But..."

"Fuck off!"

"What?"

"FUCK OFF!!" I roared at him, my hackles right up. He went off muttering, wearing a deeply wronged look. Someone stumbled into me and I shoved him aside. He rounded on me: "Who're you pushin!"

"You, you stupid drunk bastard!"

He backed off, amazed. I caught myself and remembered where I was -- Christ I'd better watch it... With my scalp prickling I worked my way back to the vans.

The second last set ended and moved offstage. Jake and his all-star one-week-old band climbed the steps. Sol was at the mike trying to announce them, but the huge groundswell of noise from the crowd defeated him and he gave up.

Jake took a mike for his sax, guitarist Allen Kwela plugged into a big Marshall amplifier, young Victor Ntoni took a mike for his double bass, Pat Matshikiza sat at the piano on the blue plastic milk crate that had served all day as a piano stool, Nelson Sibeko got behind the drums. They tried to balance, then shrugged and got going.

The final half-hour was chaos. There were people milling around the stage dancing, yelling, gesticulating, crowding the musicians. The police had given up. The crowd was in a demonic frenzy -- gyrating, hurling cans and bottles indiscriminately in the air.

I stood on the railings at the back of the stage taking photographs. I have no idea what the new band's big debut sounded like -- the music was going the other way, and I was probably too bludgeoned to have

been able to tell anyway. But afterwards they said it had been a great success, the crowd had loved them and they were all very happy.

At six o'clock the sun lowered itself behind the winter veld and the sky dimmed. Ray and Sol both rushed onto the stage and grabbed mikes.

"Stop!" they yelled. "That's all -- goodbye!"

Ten minutes later it was dark. The crowd vanished, a harrowed Terry and Stan disassembled, packed and left with lightning speed, the last of the bands drove off and the stadium was deserted, the stage bare but for the hired piano and the upturned milk crate stool.

I dragged my feet through the inches-deep litter that covered the entire front half of the ground, walked across the track and climbed the steps to the top of the stand. I looked back through the night towards the stage. A full moon split the darkness at the eastern horizon, blood red through the gathering evening smog. I watched it rise, and found I was not alone. Someone started to play the piano, though I couldn't see who it was -- I could hardly make out the stage in the darkness. He was a good pianist, with an easy, fluid style, and a tune I hadn't heard before. It was beautiful.

As soon as the whole magic disc of the moon had risen I climbed down, walked to my car and drove home with the money, leaving the day's best music to an empty stadium.

Ellis, August 1974

Dear Keith,

A problem has cropped up inasmuch as the piano we loaned you for the Mamelodi Jazz Festival was returned to us minus the keyboard. I contacted Ray Nkwe in connection with this matter and he informed me that he noticed the piano had had its keyboard removed and thought it had been removed by myself in order to prevent unwanted persons using it. Well this is not the case at all -- as you know I wasn't there. It seems as though the board has been stolen -- probably by someone who is au fait with the workings of a piano, as I think you'll agree that the removal of such a component from a piano is not an easy one.

As a result our company has been placed in an acutely embarrassing position due to the fact that the piano we loaned you was loaned to us by Bothners and they are not amused in the least. In fact they have taken a very dim view of the matter and it is doubtful whether Ellis will ever be

graced by another favour from Bothners.

Not long ago, Jack Hines made mention of the fact that you needed to purchase a piano for yourselves, which leads me to suggest to you that you take over this piano from Bothners. I'm sure that a most reasonable price could be negotiated with Bothners for the purchase of the piano and I would be only too pleased to negotiate with them on your behalf.

As far as I see it, this is the only solution to the problem as it will save face for Ellis, which is very important as we have a good name and we intend to keep it and you will also procure a piano which I know you are in need of.

I am sure I can count on your co-operation in this matter.

Yours sincerely,
Colin.

Colin never did tell me how he thought I could use a keyless piano.

Jake was already at the farm when I got home from Mamelodi that night. He was waiting with the driver of the car that had transported the band and their instruments.

"He needs R10."

"That's your business, Jake -- you're supposed to pay for transport out of the R200 I paid you this afternoon."

"But you paid me a cheque, and I haven't got any cash."

I couldn't refuse -- after all, I was carrying a sack full of money. I paid the driver and he left.

"That's R10 you owe me -- and it's your turn to make the coffee. I'll cook up something to eat later."

I still had one chore left to do, and when Jake came back with the coffee I'd emptied the sack onto the living room carpet. We stared at the jumbled pile of notes and coins.

"Will you help me count it?"

"Sure. How should we do it?"

"Let's do it outside in the wind, then we'll only have to count the coins," I suggested, horrifying Jake. "Well at any rate we'll need a bottle of something." I fetched a bottle of wine and we counted the money there on the carpet.

"... and we'll make another small pile of tens over here," I said.

"What for?"

"Us."

"Hau!"

"Jake, you saved us a lot of money this afternoon spotting that racket. It's payment for that, okay?"

When we finished counting I halved our pile, gave half to Jake and then took one note back. "That's the ten rand you owe me."

We'd kept it small, we weren't greedy. Others had been far greedier.

There had been a bit more than R4,000 in the sack. There should have been at least R15,000.

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Zebra Crossing
-- On the wrong side of South Africa's racial divide
by Keith Addison
South Africa, 1974

Stories by Keith Addison

Zebra Crossing
-- On the wrong side of South Africa's racial divide.

Kwela Jake
Sold into slavery
Mamelodi
Finding Tom Hark
Return of the Big Voice
Brother Jake

Tai Long Wan
-- Tales from a vanishing village

Introduction

Full story

Tea money

Full story

Finding Tom Hark

By Simon Bender

I think I was nine or ten years old when I first heard 'Tom Hark', and of course I had no inkling of the journey that had begun. My recollection of the TV drama it introduced is non-existent; diamonds, South Africa, and apartheid weren't even on my radar. If I tell you it was called 'The Killing Stones' it is probably not a true memory because that information is on the record label -- a very worn '45' which is the only one I still have out of hundreds we played to death on our tinny little portables.

I was a musical kid, grew up listening to my mother's 78's, and when I liked something I would play it until I wore the record out and drove my folks crazy. Music reaches deep into my soul and moves levers, pushes buttons that I can't access any other way. The ocean brings me peace, but music brings me joy. Music is far more evocative for me than any other sensory input -- it's the purest form of communication and when it happens, it's like magic -- better than sex, it's so much rarer, delightful and evanescent. Like a moment of enlightenment, it slips away when you try to hold it, leaves you with a tantalising glimpse of what our minds are capable of, and in a subliminal sense, of the road ahead.

So, why did I keep that one? Because the irrepressible life running through those two simple tunes, 'Tom Hark' on one side and 'Ry-Ry' on the other, grabbed me, spoke to me, inserted itself into my DNA like a benign but powerful retrovirus, and changed my musical life forever. I wanted to play music like that and I wanted to know the people who did... Elias and his Zig-Zag Jive Flutes...

And so it remained for ten years or more, much more than a favourite tune, something I came back to again and again, my only '45', hell, my modern turntable wouldn't even play it. I would put it on when nothing else in my eclectic collection of sounds appealed and it was always fresh, always refreshed my ears, as it still does and always will. Even then I never gave a thought to what it meant, to the lives that produced it.

Until around 1969, when I met my first South African -- Keith. Of the meetings that I look back on, this one was definitely a nexus; as when I

Forbidden fruit

Full story

No sugar

Full story

Treasure in a bowl of porridge

Full story

Hong Kong and Southeast Asia
-- Journalist follows his nose

Nutrient Starved Soils Lead To Nutrient Starved People

Full story

Cecil Rajendra
A Third World Poet and His Works

Full story

encountered 'Tom Hark' there was a powerful pull from the future, a signpost to the way I would be going, whether I knew it or not. And like so many meetings, it might never have happened. As a comfortably middle-class university student, I thought I knew all I needed to about apartheid, and when one of my jamming friends suggested I come and meet this guy from South Africa, I wasn't sure I wanted to, and nearly didn't go round to Portland Road that day. As it turned out, Keith was a free-thinker of a kind I hadn't come across before, and he gently opened my mind to so many possibilities, the world never looked the same again. I had a new Brother.

But the common thread was music. One night, improvising on guitars together, the musical alchemy was flowing. What came out could never be rehearsed, and could never be captured or repeated -- the essence of it was in the moment and we both saw it at the same time. We stopped playing and laughed with pleasure, and there were to be many other such moments out of time over the years, by no means all of them musical. Keith has the most original point of view of anyone I know, and an unparalleled ability to communicate it.

I don't remember how we got onto Kwela. The term meant nothing to me -- I don't think I'd even identified the music as South African, but as soon as Keith described the criss-crossing lines and rhythms of the penny-whistle music I was excited, because I KNEW exactly what he was talking about, and had known since I was nine. I ran home and returned with the precious '45'. We played it, and the music was renewed in me again. Now I knew where it was from, and I determined to get there as soon as I could.

It was 5 years later and I was totally Londoned-out, ready to move on. Keith and I had kept up a correspondence, not a lot of letters, but all good ones, and his recent ones were telling of a man he'd come across in the music promotion business -- a good musician, but also a bit of an astrologer and Sangoma, a witch doctor. He wanted me to meet him; not only that, Jake wanted to meet me. I sold everything I had except my guitar -- that bought me a return ticket to Johannesburg and about 3 months living money.

When I arrived unannounced in the middle of the night at Keith's farmhouse north of Joburg, I was initially confined to the taxi by a monk reincarnated as a wolf; Sam the malemute (with a shaved head, following a cut from a barbed-wire fence) wasn't about to admit anyone without the nod from Keith. I didn't realise that I'd caused minor panic inside the house among the two black musicians who were staying there with Keith, because the most likely reason for an unexpected midnight visit was a police raid, and they were breaking the law just by being there at night. And so was Keith. It was my first exposure to South Africa's repressive laws.

Leave the farmers alone
Book review of "Indigenous Agricultural Revolution -- Ecology and Food Production in West Africa", by Paul Richards

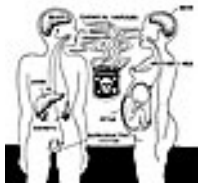
Full story

A timeless art
Some of the finest objects ever made

Full story

Health hazards dog progress in electronics sector
The dark side of electronics -- what happens to the health of workers on the production line

Full story



Mo man tai ('No problem')
-- "Write whatever you like" -- a weekly column

The next morning I met Jake -- my first black South African; a small man, sparingly built, hard to guess his age, with a skin the colour of old leather. A shy smile at first, then a ready laugh and an unforgettable voice, no surprise he was sometimes called 'Big Voice Jack' . I spent quite a bit of time in his company in my first few weeks in Johannesburg, and it was with Jake that I saw firsthand the effects of petty apartheid if you didn't happen to be white. We stood side by side in different worlds: I, the boy, was his 'boss', he, the man, was my 'boy'. In my naivety I thought we could ignore this nonsense; on reflection, I think his reticence to do so was looking out for me. I was proud when he began to call me 'Brother' too.

But the best times were the evenings -- as night fell on the Transvaal and it got colder than I ever thought it would in Africa, we would sit around the fire talking, smoking, drinking, listening to music and of course playing it too. Jake's a gifted jazzman; he plays great sax, but I couldn't really keep up with him on my guitar. I was much more interested in his penny whistles, and I could strum backup for a kwela tune. The first time we played 'Tom Hark' was exciting, but it was much more than that for me; it closed a loop that stretched back to my childhood, as though I had been waiting all my life to play this music, in this place with these friends. The sense of convergence, of fate leading to an event and a point in time was quite overwhelming. But I was even closer to 'Tom Hark' than I realised.

I told Jake how this tune had been a part of me since childhood, how I had the record safely stashed away in England, and Keith said something like: "What did you get for recording 'Tom Hark', Jake?"

* * * * * * * * * * * * * *

I thought they were having me on -- taking the mickey out of the naive white boy -- but when Jake said "Six pounds", I knew it was true. A fleeting expression of something had crossed Jake's face, not anger or bitterness, not even resentment, maybe sadness. I'm unsure at this distance in time, but I knew he wasn't pulling my leg.

"But... who's Elias?" I said, trying to get my head around the significance of this revelation.

"He's my brother, Brother Si," Jake replied, and in time I learned the whole story.

I also learnt to play the penny whistle from Jake, and I still treasure the set of all-metal Hohner whistles he helped me buy at Magnet's -- you can't get them now. My C-whistle has the chrome plating worn away

Swag bag
Death of a Toyota

Full story

Curriculum Vitae

from the finger holes, polished down to the brass like Jake's, from bending the notes the way he taught me.

Some time later I went on a road-trip from Joburg to Cape Town with Jake. Someone else was driving so we played our penny whistles most of the way. We played kwela of course, but this time I was able to show him some jigs and reels -- he called them 'puzzle tunes' and there was a lot of laughing and 'Jeewiz' as he grappled with unfamiliar cadences.

I guess the loop was fully closed in Joburg, late in 1977. Jake invited me to a recording session and I played guitar backup on 'Penny Whistle Man', which featured Jake on penny whistle and vocals. The record was a Christmas hit, and Jake made sure I received around six pounds for the session. And now I have two '45's.

I haven't seen Jake for more than 20 years, but his spirit is still with me, as it was long before I met him, from the day I first heard 'Tom Hark'.

Simon Bender
Sydney
Australia
September 5, 2002

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MIDORI HIRAGA

JOURNALIST

Nationality	Japanese
Age	28
Email	midori@journeytoforever.org

PROFESSIONAL DETAILS

Work description	Journalist
Experience	Six years
Work areas	General reporting, news/business features, social issues, Third World issues
Published	Shyukan Kinyobi, Hu-rights Osaka Newsletter, 2001 Fora, East Asia Review, Weekly Hong Kong, Hong Kong Post, Hong Kong Standard, others.
Books	Co-authored 'Document Hong Kong 1996-97', a book about the year of Hong Kong's handover to China.

HISTORY

From August 1997	Started work on Journey to Forever (Hong Kong to Cape Town Overland)
Jul. 96-present	Freelance Writer Writing articles for Shyukan Kinyobi, Hu-rights Osaka Newsletter, 2001 Forum Newsletter, East Asia Review, Weekly Hong Kong, Hong Kong Post, Hong Kong Standard, others. Co-authored the book 'Document Hong Kong 1996-97' published by Shakai Hyoron Sha in Japan in December 1997.
Dec. 97-Sept. 99	Bridge Information Systems (HK) Ltd/Dow Jones Markets (HK) Ltd -- Financial services online
Apr. 97-Oct. 97	AVCJ Holdings Ltd -- Senior Staff Writer Investigating and writing articles for Asian Venture Capital Journal and Mergers & Acquisitions Asia, covering private equity investment and merger and acquisition activities of Japanese companies in Asia.

Jul. 96-Mar. 97	TOWA Securities (Hong Kong) Ltd (The Sanwa Bank Group) -- Analyst Writing Hong Kong Market Daily Comment every day, translating and editing Asia Weekly, which covers the stock markets in Hong Kong, China, Singapore, Malaysia, Thailand, Indonesia and the Philippines.
Jun. 95-Jul. 96	Hong Kong Standard, Reporter Covering general news, feature stories, education, as the only Japanese reporter in the newsroom.
Oct. 94-May 95	Pasona Press (HK) Co., Ltd. Daily local news and Hong Kong, Taiwan, China business news for a fax-based Japanese newspaper, Hong Kong Business Post.
Jan. 94-Jul. 94	TV MAN UNION, Tokyo, Japan Researcher Researching and conducting interviews for a TV production house.

EDUCATION

Aug. 94-May 95	The Chinese University of Hong Kong Studied Mandarin and Journalism on the Rotary Club 1994-95 Academic Year Ambassadorial Scholarship program. Varsity Magazine, CUHK September 1994-May 1995 Staff writer and sub-section editor for the English magazine published by the Department of Journalism and Communication, the Chinese University of Hong Kong.
Apr. 90-Mar. 94	International Christian University, Tokyo, Japan Bachelor of Arts, March 1994 Majored in Japan Studies and modern history of Japanese relations with Southeast Asia. ICU Student Newspaper 1991-1994 Editor-in-Chief and President of the monthly bilingual student newspaper team at the International Christian University.

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How I became a Third World journalist

by Midori Hiraga

Stories by Midori Hiraga

How I became a Third World journalist

English

On the 50th anniversary of Hiroshima

Full story

Japanese use holiday to purge guilt over the past

Full story

Chinese migrant's battle to obtain degree

Full story

Filipino arts group shares message of hope and justice

Full story

Japanese

Hong Kong's handover 1997

Full story

"We are not products" -- Foreign domestic helpers in Hong Kong

Full story

June is a rainy season in Japan -- all the leaves of early summer darken color to a beautiful green -- and my father gave the name "Midori", the Japanese word for green, to his second daughter, born in June 1971.

As a child in a small town near Hiroshima, I was very much aware of the war and of what it did to the people, both inside and outside Japan. In college I studied some of the modern history of Southeast Asian countries and China, and learnt what Japanese had done to the people of the region. What I hated most was the propaganda teaching people to hate the enemies and look down on other Asian people, and how Japanese people followed it, partly because of lack of information about other people and actual contact on an individual human basis. As a child, I thought it would have been more difficult for the government to mislead people if they had known more about other Asian people and had made friends with them.

So I began to aim at being a journalist so I could help to bridge the gap between Japan and the rest of the world.

Also, I grew up seeing pictures of starving children in Cambodia and Africa, and I wanted to do something about it. When I was a teenager a book called "Ningen-no-Daichi (The Earth of Men)" written by Michiko Inukai opened my eyes to the world's refugee, hunger, and environment problems, leading me to Third World issues.

Yet when I finished college I was not sure what to do with my life (thanks to the test-oriented Japanese education system!). Neither working for a Japanese newspaper nor for the United Nations seemed the way to fulfill my aim, and I wanted to have more experience in life first. I was lucky enough to be offered a scholarship by the Rotary Club, so I came to Hong Kong to study as an overseas student. I studied Mandarin, then Cantonese, at the Chinese University of Hong Kong. I stayed with local Chinese students, mixed with them and travelled together to Thailand. I also travelled in mainland China alone for three weeks, visiting friends' friends, taking local trains and buses, and talking with local people.

Life as the only Japanese reporter on an English newspaper in Hong Kong

Full story

Curriculum Vitae

After finishing my university course, I joined an English-language newspaper, the Hong Kong Standard, as a reporter. This was just before the Handover to China and the whole Hong Kong society was changing rapidly, often leaving its people confused. In the course of my work I met hundreds of local Chinese, young and old, and people from all over the world, especially from South East Asia. I became involved in the local Filipino society and saw the life of struggle led many of Hong Kong's domestic helpers, migrant workers, and illegal over-stayers.

Hong Kong gave me a condensed picture of the world, where rich is rich but poor is poor. In Hong Kong, the gap is extreme and you can see it by just walking a few blocks. I wrote articles about it, and kept on writing even after I left the newspaper, as a freelance writer for Japanese magazines. At the end of 1997 I co-authered a book on the handover. But I was not satisfied with my career as a reporter or a writer.

Then I met Keith Addison, who told me he was a Third World journalist. I hadn't heard that description before, and it opened the whole world to me just as I was questioning the way of my life: this is what I wanted to do.

I began studying the world's food, environment and development issues under the guidance of this strict but patient teacher. Later, when he first told me of this adventure, I immediately applied to join, but was rejected -- because of lack of experience and knowledge, and being too young and vulnerable. It took months to convince him of my capability and contribution, but finally I was admitted as a partner in the Journey to Forever project.

Fixing the tank of my Land Rover -- what a struggle!

That was the beginning of all the hard work and struggle to develop this huge project. Still, I was happy building the project's experimental organic garden from scratch, restoring the Land Rovers, and learning about the world's real issues.

This journey is the biggest challenge in my life, and the best training to be a Third World journalist. I hope it will also be an exciting adventure for many Japanese people through my writings.

My mother always told me I was just an ordinary girl, and this adventure was heart-breaking news for my parents, who still wish me to follow the ordinary life of a Japanese woman. I am sorry for making them worry

about my safety, but this is the adventure I have sought all my life.

It was my father who named me "green", and my mother who gave me the book by Ms Inukai, and I'm deeply grateful to them for leaving me to do what I want.

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On the 50th anniversary of Hiroshima

by Midori Hiraga

Published in Hongkong Standard, 6th August 1995

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When I came to Hong Kong last year, I made up my mind not to speak about Hiroshima to people here. I thought: how can I talk about it before I understand the great suffering of people in Asian countries, which was caused by Japanese?

I am a Japanese who grew up in Hiroshima, and I have heard many stories about the Atomic Bomb.

My father was five years old at that time. He lived in a town east of Hiroshima city named Saijyo, where my parents live.

He was playing in the backyard of his house that fatal morning. Sometime after eight o'clock, he and his playmates saw an American B-29 bomber in the sky flying towards Hiroshima city.

He went back to playing, and then he heard the sound of a huge explosion. They didn't know what it was. A woman neighbour said the gas tanks in a nearby town had been attacked by the US planes. Nobody knew what was happening in the city.

Then, as evening fell, injured victims started arriving and told the local people how Hiroshima city had been destroyed. They told of a world of hell inside the city.

That morning, my grandfather was working in the city about a kilometer from where the bomb exploded. He never came back home.

My uncles went to the city to look for their father. What they found was my grandfather's white bones, identified by the signs of old surgery he had had.
My uncles, whom I never met, suffered nightmares ever after that. They were still young, just teenagers. What they saw in the city then searching for their father was hell -- too terrible to be true.

The victims were severely burned, their skin falling apart and hanging from their hands, their internal organs bursting from holes in their bodies, their eyes popped out -- some even had their eyeballs in their hands, dreadful creatures stumbling around crying out for water...

My uncles died years later of leukemia because they were exposed to the radiation in the search for their father. Even when they were alive, their lives lay in ruins under the shadow of the nightmare of the Atomic

Bomb, their family life was wrecked.

But I hold no hatred against American people. On the contrary, I stayed in the US for a year as an exchange student, a joyful year with my host family and my friends there.

What I hate is wars.

The situation in Hong Kong is different to that in Japan.

I believed I knew more about the war than most Japanese students. I knew about the Japanese occupation of this region, the cruelty of the solders in the Nanjing massacre, the "live" experiments on 731 troops, the treatment of the prisoners-of-war, and the many other evil things they had done.

Since my childhood, I have heard and read many terrible stories inside and also outside of Japan. In those days, there were plenty of books and historical material about what the Japanese army did in China and Southeast Asia. Most of my knowledge about the war came from my own reading and listening, not from school textbooks.

Still, it was only after I came to Hong Kong that I learned how terrible the suffering was in real life, and realized that what I had learnt in Japan was only a dim knowledge of the war with no real meaning for me.

On July 7th this year, I followed the demonstration of war victims from Chater Garden to the Japanese Consulate, demanding that Japan apologize and compensate the victims. I was to cover the story as a reporter.

The demonstrators did not know I was a Japanese, but I knew it very well that I was the only Japanese among angry Chinese people. I could deeply understand their anger against Japan.

When I visited the Nanjing massacre memorial and saw the exhibits of hundreds of bones of the victims and the heartwrenching pictures, I thought I could never face Chinese people without acknowledging these facts.

Since then, I have learned more about how the Japanese attacked Hong Kong, how the people starved, and how they killed so many innocent people here. I went to Japanese book stores in Causeway Bay to learn more. There are about 30,000 Japanese people living in Hong Kong, so I thought the shops there would have books about the history of the Hong Kong occupation. But there were only a few books on war. Instead, there were many books on business and investment in China and Asian countries, and travelling in Asia.

Some Japanese people are concerned about the sufferings of Asian people. Many books have been written about how people suffered in the Japanese attack, and many Japanese people support the demands for compensation.

But their work is still a minority voice in Japan, and I'm afraid most Japanese still remember the bombings of their homeland and feel they were the victims of the war.

The 50th anniversary should not end anything. This is the time to begin again to learn history. At the memorial monument in Hiroshima Peace Park, the phrase is written on the tomb of the Atomic Bomb victims: "Please rest in peace, we will never err again."

There are thousands of people who cannot rest in peace because Japan hasn't apologized for nor compensated what she had done to the people of the Asian countries.

This is just the beginning of my quest to find out what happened during the war, and why it happened, and to tell Japanese people about it. I believe understanding between peoples is the only way to prevent such a tragedy ever happening again.

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Japanese use holiday to purge guilt over the past

by Midori Hiraga

Published in Hongkong Standard, 20 September 1995

Stories by Midori Hiraga

How I became a Third World journalist

English

On the 50th anniversary of Hiroshima

Full story

Japanese use holiday to purge guilt over the past

Chinese migrant's battle to obtain degree

Full story

Filipino arts group shares message of hope and justice

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Japanese

Hong Kong's handover 1997

Full story

"We are not products" -- Foreign domestic helpers in Hong Kong

Full story

Life as the only Japanese reporter on an English newspaper in Hong Kong

Full story

THEY spent HK$12,000 each for a summer holiday in Hong Kong recently but this was no ordinary break for a group of Japanese -- they wanted to learn about their country's war record in the territory.

There were more than a dozen of them on this tour aimed at "visiting the remains of Japanese army occupation in Hong Kong and understanding Japanese responsibility as the invader".

Japanese troops occupied Hong Kong from the "Black Christmas" of 1941 to 1945. In the three years and eight months, the colony's people were subjected to great suffering.

But this history is not well known to most of the Japanese public.

People tend to remember more what happened in their neighbourhood. What most Japanese people experienced during the war was the American B-29 bomber attacks on their cities and the deaths of their relatives.

"Living in Japan meant that our image of the war was one of Japanese suffering and hardship," one of the tour members said.

"It is difficult for the Japanese public to see themselves as invaders because that role was played outside the country."

The tour was organized by Yukio Wani, a Japanese history teacher.

The group first learnt the basic history of Hong Kong at the Museum of History in Tsim Sha Tsui. On the second day, they attended a demonstration staged by the Hong Kong Reparation Association and joined its 600 members in demanding a full apology and compensation for the Hong Kong war victims. They also attended the 50th commemoration ceremony of liberation.

And they visited the war memorial monuments, the battle sites and the places which housed the "comfort women" who were forced to serve the Japanese soldiers. They also visited the "kamikaze caves" in Lamma Island, where the Japanese army forced local residents to dig caves to hide their "suicide attack boats" and then killed the residents to ensure secrecy.

Curriculum Vitae

The tourists were accompanied by Hong Konger Ko Tim-keung, who is fluent in Japanese and an authority on Hong Kong history.

He has written several books on the Japanese occupation of Hong Kong.

The Japanese visiters at a local demonstration seeking war compensation

"The Japanese public do not know what happened during the Japanese military occupation of Hong Kong," said Mr Wani. "There is no documented study of this period in Japanese."

Though many Japanese people now visit Hong Kong, their main concern is business, shopping, sightseeing. Not many are interested in the history of Japan's occupation.

Based on his belief that true human relations can only be established on a full mutual understanding of their common history, Mr Wani has been organizing similar tours for years.

"I believe both the Japanese and Hong Kong public must come to understand the history of the occupation period. This is the only way to establish true friendship between us," he said.

Mr Wani works actively to help Hong Kong war victims in their campaign for compensation. He also researches the occupation.

He was originally drawn to the subject by coincidence. In 1991, a friend asked him to help research the military currency forced upon Hong Kong people, who never received compensation for the subsequently worthless cash.

"To tell the truth, my first impression of the victims wasn't good. The first thing they did was to push the bills in front of me and ask for cash," he said. "All they wanted was the money."

Mr Wani met several Hong Kong war victims in Japan. The older victims were unfriendly.

But when he visited Hong Kong and listened to the victims' stories, he found there were more serious problems than the military currency.

"The malevolent occupation by the Japanese army was a more serious problem than the problem of military bills," he said.

Because of the cruel treatment they suffered, Hong Kong people had a complicated view of today's Japanese people.

"Hong Kong people admire the Japanese for some reasons and hate them for others," Mr Wani said. "They enjoy Japanese movies, Japanese comics and electronic products but they hate Japan because of war memories.

"These complicated views can be straightened only by fully understanding history."
Though sometimes war victims' sole concern may be compensation, Mr Wani thinks that it is a natural reaction but there is more to be asked for.

He said they need help to persuade the Japanese government to agree to their demands.

"The payment for military currency is only a part of a huge problem which the Japanese occupation gave Hong Kong society," he said. "The Japanese failed to recognize the problems left behind."

He said the Japanese had done nothing to record history and recognize it.

"Oral stories from the victims are not enough. We need to gather the written documents and must have a comprehensive analysis of the Japanese occupation of Hong Kong.

"Written documents and research are urgently needed in order to help the war victims. It is difficult for a group of old citizens to fight against a government without these documents.

"And research is essential for the Japanese to understand the impact their occupation had on Hong Kong society.~

Some of the tour members were photographers. One of them said he took plenty of pictures of the military currency -- pictures that will help convey the problem to the Japanese public.

Others were teachers. They were keen to learn the facts so that they could convey them to their students.

"Some of the Japanese politicians are backed by families of war veterans and that does not help the Asian war victims' battle for compensation," a secondary teacher said.

"We cannot rely on the politicians. Each citizen has to take action."

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Chinese migrant's battle to obtain degree

by Midori Hiraga

Published in Hongkong Standard, 2 October 1995

Stories by Midori Hiraga

How I became a Third World journalist

English

On the 50th anniversary of Hiroshima

Full story

Japanese use holiday to purge guilt over the past

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Filipino arts group shares message of hope and justice

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Life as the only Japanese reporter on an English newspaper in Hong Kong

Full story

A MAINLAND student was forced to repeat five years of her education when she migrated to Hong Kong seven years ago.

Second-year university student Joyce Suen Chun was 19 when she arrived in the territory and was placed in Secondary 4.

"Those years in secondary school were just a waste of time. Most of what I learnt in China was just repeated," she said.

Ms Suen, 26, finally finished her long education last May when she received a degree in Business Administration from the Chinese University.

Repeating the school years was the only way she could obtain a university place, she said.

"If the universities had a system to qualify migrant students from the mainland, I could have saved several years of my life."

Ms Suen's plight is not unique. A recent survey by the Hong Kong Federation of Youth Groups revealed that most migrant students experienced similar humiliation when looking for a suitable school, and many were forced to repeat a few years in order to enter the Hong Kong education system.

Hong Kongers say the reason for mainland students being forced to repeat school years is that their English is poor. But Ms Suen said this was untrue.

"The Hong Kong public believes migrant students are bad at English," she said. "This might be true for primary and early secondary students." But she said this was because mainland students did not start learning English until they entered secondary school.

"But university students in the mainland are quite good at English. English has always been a problem for me, but compared with other Hong Kong students I wasn't too bad," she said.

When Ms Suen left her home in Hunan province in 1988, she was a second-year university student studying for an accountancy degree.

Curriculum Vitae

Although she was the youngest in her class, she was one of the top students.

But when she came to Hong Kong the universities did not accept her mainland qualifications, and had no way of qualifying students.

The Chinese University required Ms Suen to pass the Hong Kong Certificate of Education Examination (HKCEE) and the Higher Level Examination.

To pass the two exams, she had to go back to Secondary 4 -- at the age of 19.

"I wanted to join Form 5 to speed up my journey to university. But most of the HKCEE was taught in Form 4 so I had to go back another year," Ms Suen said.

Studying with younger classmates was a depressing and humiliating experience.

"I was isolated, and seldom spoke to my classmates or made friends with them. I became very shy," Ms Suen said.

Looking for a school was another problem she had to face. Several government schools rejected her because she was over 15, the upper age limit for compulsory education in Hong Kong.

She became dejected and wanted to give up her education. Her father spent a month searching for a school. Ms Suen and her family received no help from the government or social workers.

"We didn't know if there was any assistance we could have applied for at the time," she said.

After this humiliating experience, a friend of Ms Suen's parents told her about the Mong Kok Workers' Children School, where she finally found a place.

Today the situation for new migrants has improved somewhat. At that time the government paid little attention to migrant students, and few teachers or students spoke Putonghua.

"Now the public knows about the situation of migrant children, and the government also tries to help them. So the situation is much better," Ms Suen said.

The number of migrants is increasing, with about 7,500 school-age migrants coming to Hong Kong between October 1993 to September

1994.

The Education Department has begun 60-hour courses to help new immigrant children adapt to Hong Kong, and is aiming to review its induction and English courses.

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Filipino arts group shares message of hope and justice

by Midori Hiraga

Published in Hongkong Standard 23 January 1996

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Full story

BUGKOS -- Tagalog for unity -- uses music, theatre and the arts to protest against the inequities in Philippine society and to empower the oppressed.

The Philippines' refuge for concerned artists, Bugkos is a grassroots-based centre for people's art and literature.

Once a culturally diverse country with rich natural resources, the Philippines is still struggling to regain its self-esteem after the dark years of the dictatorial Marcos regime.

Today 85 % of the population live below the poverty line. With an economy still reeling from centuries of foreign domination, many people suffer from hunger, illness, and family separation.

Bugkos sings songs of liberation at their show at Fringe Club

The change in government administration has not eased the people's suffering.

"The situation is getting worse," a member of Bugkos says. "In order to solve poverty, we need to fight imperialism, the feudal system and the bureaucratic capitalists."

Bugkos, established in 1988 to bring art groups together under one roof, aims to help ordinary Filipinos regain their liberty through art.

Although the government has not banned Bugkos, it does not encourage the group's activities. Bugkos and its affiliate groups perform in theatres and on streets, telling people about the struggle of the oppressed.

They aIso visit villages in the mountains and other remote areas to organize local people and teach them how to use art to express their anger at the authorities' indifference to their plight.

Last week, Bugkos brought their brand of music and art to Hong Kong. In a memorable show at the Sheung Wan Civic Centre, the group deeply impressed the audience with their play "Asdang: A People's Rising".

Curriculum Vitae

The play depicts the Philippines suffering many invasions -- first by priests clutching swords and rosaries. Next came a brutal eagle, then a chameleon and finally a snake -- all symbols for the different people who invaded the Philippines under the guise of saving it.

Spain colonized the country of 7,100 islands for 400 years, followed by the United States and lastly Japan -- but in the play, Bugkos showed another "invader" who made life difficult for Filipinos -- the dictator Marcos.

"There is no country in the world which was liberated so many times," the Bugkos pamphlet says.

"Spain came to the Philippines in 1521 saying it liberated local people from ignorance and idol worship.

"America came in 1898 and declared the liberation of people from Spanish occupation. The Japanese came in 1941 to liberate people from America and America came back three years later saying they liberated the people from Japanese occupation.

"From then on, we had eight elections and every president said they liberated the Filipino people."

Bugkos also performed at the Fringe Club, singing songs of liberation and freedom from suffering.

Santa Filomena is a song about a town ordered demolished by government authorities in the 1980s. It is about how the military burned the houses and destroyed the land of small farmers, and about people crying over their lost town.

Santa Filomena was among several towns erased from the Philippine map to give way to infrastructure construction that mainly served the capitalists and enforcers of the feudal system, a Bugkos member says.

In the play, Annie Ruth Calambacal sang the song for the Hong Kong audience.

A conscientious college student in the 1980s, Annie Ruth was attracted to the group by its cultural theme and its struggle against the inequities in society.

"When the police first harassed us, I knew the government was not serving the interests of the people," says Annie, a musician.

Because most of Bugkos's performances attacked the oppressive

government and its policies, the group was often harassed by the police.

Bugkos executive officer Romeo Dongeto recalls an incident in which one of their colleagues was killed by soldiers for practicing the art he believed in.

"He was conducting a cultural meeting with the farmers," Mr Dongeto says. "The military tagged him as a communist and killed him."

Members say they have learned to be quick when performing in front of ordinary people in the streets. They fear the military and police intelligence agents of the kind who killed their colleague.

During their stay in Hong Kong, the group also held a three-day workshop on people's theatre for students and the public.

In the workshop, a Bugkos facilitator helped participants to express their inner feelings about any form of injustice they may be aware of.

The participants also viewed a documentary video about the people's protest movement in the Philippines.

"Some labourers don't know how to express their suffering," Yoyo Yau, a Hong Kong Polytechnic University student, said. "But after attending this workshop, I learned that Filipinos can effectively use cultural activities to protest against their government."

Local workshop participants in a street performance after learning from Bugkos members

At the end of the workshop, groups of five people each performed a street play at Chater Garden in Central.

Before performing, the participants discussed their chosen topic and how they would express their message.

"I did not know the theatre can really do something for people. It can be used as a tool," one participant said.

The workshop's facilitator, Ernesto Marcelo, said the effectiveness of street theatre was beyond doubt.

At the end of the discussions, one participant said they needed to learn from the experience of the Filipino cultural movement.

"After 1997 (Hong Kong's handover to China), we might experience what you are experiencing," the participant said.

Story and pictures: Midori Hiraga

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Comment

Biotech has bamboozled us all

Studies suggest that traditional farming methods are still the best

Special report: what's wrong with our food?

George Monbiot
Guardian

Thursday August 24, 2000

The advice could scarcely have come from a more surprising source. "If anyone tells you that GM is going to feed the world," Steve Smith, a director of the world's biggest biotechnology company, Novartis, insisted, "tell them that it is not... To feed the world takes political and financial will - it's not about production and distribution."

Mr Smith was voicing a truth which most of his colleagues in biotechnology companies have gone to great lengths to deny. On a planet wallowing in surfeit, people starve because they have neither the land on which to grow food for themselves nor the money with which to buy it. There is no question that, as the population increases, the world will have to grow more, but if this task is left to the rich and powerful - big farmers and big business - then, irrespective of how much is grown, people will become progressively hungrier. Only a redistribution of land and wealth can save the world from mass starvation.

But in one respect Mr Smith is wrong. It is, in part, about production. A series of remarkable experiments has shown that the growing techniques which his company and many others have sought to impose upon the world are, in contradiction to everything we have been brought up to believe, actually less productive than some of the methods developed by traditional farmers over the past 10,000 years.

Last week, Nature magazine reported the results of one of the biggest agricultural experiments ever conducted. A team of Chinese scientists had tested the key principle of modern rice-growing (planting a single, hi-tech variety across hundreds of hectares) against a much older technique (planting several breeds in one field). They found, to the astonishment of the farmers who had been drilled for years in the benefits of "monoculture", that reverting to the old method resulted in spectacular increases in yield. Rice

blast - a devastating fungus which normally requires repeated applications of poison to control - decreased by 94%. The farmers planting a mixture of strains were able to stop applying their poisons altogether, while producing 18% more rice per acre than they were growing before.

Another paper, published in Nature two years ago, showed that yields of organic maize are identical to yields of maize grown with fertilisers and pesticides, while soil quality in the organic fields dramatically improves. In trials in Hertfordshire, wheat grown with manure has produced higher yields for the past 150 years than wheat grown with artificial nutrients.

Professor Jules Pretty of Essex University has shown how farmers in India, Kenya, Brazil, Guatemala and Honduras have doubled or tripled their yields by switching to organic or semi-organic techniques. A study in the US reveals that small farms growing a wide range of plants can produce 10 times as much money per acre as big farms growing single crops. Cuba, forced into organic farming by the economic blockade, has now adopted this as policy, having discovered that it improves both the productivity and the quality of its crops.

Hi-tech farming, by contrast, is sowing ever graver problems. This year, food production in Punjab and Haryana, the Indian states long celebrated as the great success stories of modern, intensive cultivation, has all but collapsed. The new crops the farmers there have been encouraged to grow demand far more water and nutrients than the old ones, with the result that, in many places, both the ground water and the soil have been exhausted.

We have, in other words, been deceived. Traditional farming has been stamped out all over the world not because it is less productive than monoculture, but because it is, in some respects, more productive. Organic cultivation has been characterised as an enemy of progress for the simple reason that it cannot be monopolised: it can be adopted by any farmer anywhere, without the help of multinational companies. Though it is more productive to grow several species or several varieties of crops in one field, the biotech companies must reduce diversity in order to make money, leaving farmers with no choice but to purchase their most profitable seeds. This is why they have spent the last 10 years buying up seed breeding institutes and lobbying governments to do what ours has done: banning the sale of any seed which has not been officially - and expensively - registered and approved.

All this requires an unrelenting propaganda war against the tried and tested techniques of traditional farming, as the big companies and their scientists dismiss them as unproductive, unsophisticated and unsafe. The truth, so effectively suppressed that it is now almost impossible to believe, is that organic farming is the key to feeding the world.

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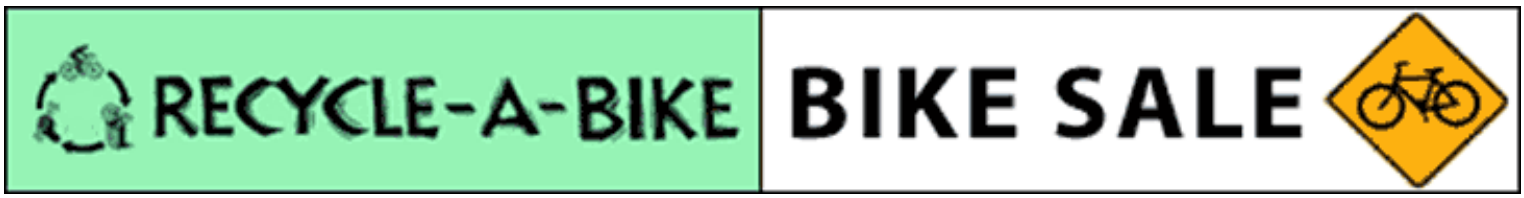

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Norfolk Genetic Information Network

The following article by Jules Pretty, Director of the Centre for Environment and Society at the University of Essex, is taken from the magazine of the Genetics Forum,'SPLICE', August/September 1998 Volume 4 Issue 6. More articles from SPLICE can be seen on their website as can details of how to subscibe.

Feeding the world?

Jules Pretty examines the myths and realities of sustainable farming's quiet revolution

Statements of fact

Ever since we started farming some 10,000 years ago, there has been a constant struggle to make sure that enough food is produced to feed everyone. This challenge has become ever more acute in the last half of this century. Even though we can put people on the moon, we simply cannot find a way to feed the world's population And the problem will get worse before it gets better. This much is agreed, but what we do about it is highly contested. Let's start with some facts. The world population is now 5.9 billion people. It is still increasing, and will eventually stabilise somewhere between 8 and 11 billion. Most of this growth will occur in the poorer countries of the world. Today, a seventh of all the world's people are hungry, 800 million of them. A quarter of these are children.

Food production will have to increase, otherwise we could be faced with crises of epic proportions. But it is not a simple problem. We actually produce enough food in the world to feed everyone with a nutritious and adequate diet now - on average 350 kg of cereal per person. A good deal of cereal is turned into meat, milk and other animal products which in energy terms is inefficient. This reduces the total amount of food available. But a more important factor is that most hungry people are poor and cannot afford to buy food. Poor farmers cannot afford expensive modern technologies that could increase their yields. What they need are readily available and cheap means to improve their farms.

And there are signs that a quiet revolution in the world food system is beginning to occur.

Sustainable highlights

*** some 223,000 farmers in southern Brazil using green manures and cover crops of legumes and livestock integration have doubled yields of maize and wheat to 4-5 tons/ha;**

*** some 45,000 farmers in Guatemala and Honduras have used regenerative technologies to triple maize yields to some 2-2.5 tons/ha and diversify their upland farms, which has led to local economic growth that has in turn encouraged re-migration back from the cities;**

*** more than 300,000 farmers in southern and western India farming in dryland conditions, and now using a range of water and soil management technologies, have tripled sorghum and millet yields to some 2-2.5 tons/hectare;**

*** some 200,000 farmers across Kenya who as part of various government and non-government soil and water conservation and sustainable agriculture programmes have more than doubled their maize yields to about 2.5 to 3.3 t/ha and substantially improved vegetable production through the dry seasons;**

*** 100,000 small coffee farmers in Mexico who have adopted fully organic production methods, and yet increased yields by half;**

*** a million wetland rice farmers in Bangladesh, China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand and Vietnam who have shifted to sustainable agriculture, where group-based farmer-field schools have enabled farmers to learn alternatives to pesticides whilst still increasing their yields by about 10%.**

The myth makers

First, though, it's important to look at the myth makers who believe in the 'techno-fix' of genetic engineering as a solution to the looming crisis.

One of the biggest advocates for genetically engineered crops is the American company, Monsanto. Their public relations campaign, 'Let the Harvest Begin' (sic), states that Europeans should stop being selfish in refusing to accept GMOs (genetically-modified organisms) because that is "a luxury our hungry world cannot afford" They say that "agricultural biotechnology will play a major role in realising the hope we all share. Accepting this science can make a dramatic difference in millions of lives".

Also, advocates have not been slow to play the environmental card. But this is done in a remarkably naive way. It is a vital part of the public relations management to persuade citizens in the North to accept the GM technologies, yet it betrays a lack of understanding of developing country agricultural, economic and social systems. Michael Wilson of the Scottish Crops Research Institute said in 1997 - "to feed 10.8 billion people by 2050 will require us to convert 15 million square miles of virgin forest, wilderness and marginal land into agro-chemical dependent arable land. GM crops hold the most important key to solve future problems in feeding an extra five billion mouths over the next 50 years".

"We actually produce enough food in the world to feed everyone with a nutritious and adequate diet now"

To anyone who comes from developing countries or has worked in them, this is simply nonsense. Replying to a comment in late 1997 by a British scientist who said that "those who want it [GMOs] banned are undermining the position of starving people in Ethiopia", Tewolde Berhan Gebre Egziabher of the Institute for Sustainable Development in Addis Ababa, said that "there are still hungry people in Ethiopia, but they are hungry because they have no money, no longer because there is no food to buy... we strongly resent the abuse of our poverty to sway the interests of the European public".

The huge number of people in severe poverty and hunger is a dreadful indictment of all of us. Something must be done.

But that something is not to say we must pursue a path of genetic modification and hang the consequences. I am perfectly open to be persuaded of the benefits of genetic modification - such as for novel treatment of cystic fibrosis or cancers - but not when the feeding the world myth is trundled out again and again.

Perhaps a cereal crop will be engineered to have bacteria in the roots that fix free nitrogen from the air. This would be a tremendous benefit for poor farmers. But unless this technology is cheap or freely available, it seems very unlikely that the people who need it most would ever have access. And what about the plans for 'terminator-technology'? These are seeds that die after one year so that farmers cannot save the seed and use it again. Will this really benefit the 2 billion people in developing countries currently relying on largely 'unimproved' agricultural systems?

Biotechnology is not currently a necessary precondition for feeding the world. However, it is fair to say that improvements to farming will arise from genetic engineering if the research is public-funded and for the public good. Biotechnology is therefore unlikely to benefit the poor in the short term. These technologies are expensive to develop, estimated at $1 million per gene, and

companies are expecting to recoup costs as well as make large profits on sales.

So who will feed all those people in developing countries? The answer to this question is simple - farmers in those countries, using sustainable methods of production.

Sustainable agriculture - the quiet revolution has started

Quietly, slowly and very significantly, sustainable agriculture is sweeping the farming systems of the world.

Put simply, sustainable agriculture is 'farming that makes the best use of nature's goods and service whilst not damaging the environment.' It does this by integrating natural processes such as nutrient cycling, nitrogen fixation, soil regeneration and pest predators into food production processes. It minimises the use of non-renewable inputs (pesticides and fertilisers) that damage the environment or harm the health of farmers and consumers. And third, it makes better use of the knowledge and skills of farmers, so improving their self-reliance and capacities.

"We strongly resent the abuse of our poverty to sway the interests of the European public"

This sequence is very important. During this century, modern agriculture has seen external inputs of pesticides, inorganic fertiliser, animal feedstuffs, energy, and machinery become the primary means to increase food production. These external inputs, though, have substituted the free, natural control processes and resources. Pesticides have replaced biological, cultural and mechanical methods for controlling pests, weeds and diseases; inorganic fertilisers have substituted for livestock manures, composts. nitrogenfixing crops and fertile soils; and fossil fuels have substituted for locally-generated energy sources. What were once valued local resources have all too often become waste products.

The basic challenge for sustainable agriculture is to maximise the use of locally-available and renewable resources.

This sounds good - but does it work? Are there sufficient resources and opportunities to turn unproductive farms into surplus-producing ones?

Remarkably, the best evidence comes from those very countries of Africa, Asia and Latin America that are said to need most the 'modern' technologies produced by large companies. Where whole communities have been involved in the complete redesign of farming and other local economic activities, the sustainability dividend is very large. The regenerative technologies and practices are hugely beneficial for both farmers and rural environments. There is more natural capital from fewer external inputs. More food output from fewer fossil-fuel derived inputs.

The improvements are of two basic types. First, sustainable farming is taking root in the resource-poor areas, those that have remained largely untouched by modern technologies of the past 40 years. Here there is a two to threefold increase in food output

The second is occurring in the higher-input systems where the so-called 'Green Revolution' has already had an impact on food output, but where there are concerns that yield increases have slowed or stopped and where high use of pesticides causes damage to human health and environments. Here the dividend comes from a greatly reduced use of pesticides - they are replaced by natural predators, habitat redesign, multiple cropping and the like - whilst increasing yields by a small amount, typically 10%.

Recent evidence from 20 countries has found more than 2 million families farming sustainably on more than 4-5 million hectares.

This is no longer marginal. It cannot be ignored. What is remarkable is not so much the numbers, but that most of this has happened in the past 5-10 years. Moreover, many of the improvements are occurring in remote and resource-poor areas that had been assumed to be incapable of producing food surpluses.

The myths and beyond

Another cog in the myth makers' wheel is the expected response of industrialised countries to sustainable agriculture.

At the beginning of the 1990s, the former US Secretary of Agriculture, Earl Butz, said we could move to more sustainable farming, but "before we move in that direction, someone must decide which fifty million of our people will starve. We simply cannot feed, even at subsistence levels, our 250 million Americans without a large production input of chemicals, antibiotics and growth hormones".

Again, this view is simply nonsense, as it once again ignores what is happening right now. In a study for my new book The Living Land, I looked at projects in seven industrialised countries of Europe and North America. Farmers are finding that they can cut their inputs of costly pesticides and fertilisers substantially, varying from 20-80%, and be financially better off. Yields do fall to begin with (by 10-15% typically), but there is compelling evidence that they soon rise and go on increasing. In the USA,

for example, the top quarter sustainable agriculture farmers now have higher yields than conventional farmers, as well as a much lower negative impact on the environment.

The challenge is still massive. Sustainable farming can greatly improve the productivity of the land. It has already done so for more than two million families in the past five to ten years. Yet there is still a very long way to go. And we need to inform our citizens about what is happening, so that they can form fair judgements on the alternatives we may or may not seek to promote in the name of 'feeding the world'.

Jules Pretty is Director of the Centre for Environment and Society at the University of Essex. His most recent book, "The Living Land.- Agriculture, Food and Community Regeneration in Rural Europe", is published this month [August 1998] by Earthscan Publications of London. An earlier book "Regenerating Agriculture: Policies and Practice for Sustainability and Self-Reliance" (Earthscan, 1995) deals mainly with sustainable agriculture in developing countries.

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Crotalaria juncea L.

Fabaceae
Sunnhemp, Indian hemp, Madras hemp, Brown hemp, Sannhemp

Source: James A. Duke. 1983. Handbook of Energy Crops. unpublished.

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Uses

Sunnhemp is cultivated for the strong bast fiber extracted from the bark, which is more durable than jute. Fiber is used in twine, rug yarn, cigarette and tissue papers, fish-nets, sacking, canvas and cordage. Sunn fiber is stronger when wet, and is fairly resistant to mildew, moisture and microorganisms in salt water. It is one of the oldest known fibers in the Indo-Pakistan subcontinent, as mentioned in ancient Sanskrit literature. It is widely grown throughout the tropics as green manure, the dried stalks and hay being used as forage for livestock. Although reported to be poisonous to livestock, seeds are fed to horses in the Soviet Union and to pigs in Rhodesia.

Folk Medicine

The seeds are sometimes used medicinally, said to purify the blood. Seeds are also used in impetigo and psoriasis, and as an emmenagogue.

Chemistry

Raw sunnhemp contains 0.61% ash, 9.6% hygroscopic water, 2.8% aqueous extract, 0.55% fat and wax, 80.0% cellulose, and 6.4% pectin bodies, (CSIR, 1950). Dried as cattle feed, the stalks contain 14.4% moisture, 1.1% ether extract, 11.3% albuminoids, 35.8% carbohydrate, 27.4% woody fiber, and 6.4% soluble mineral matter. Seeds contain 8.6% moisture, 34.6% crude protein, 4.3% fat, 41.1% starch, 8.1% fiber, and 3.3 ash. (CSIR, 1950). Seeds are reported to contain trypsin inhibitors, and are said to be poisonous to cattle. Seeds contain 12.6% oil, with 46.8% linoleic acid, 4.6% linolenic acid, and 28.3% oleic acid, with, by difference 20.3% saturated acids (Zafar et al, 1975).

Description

Tall herbaceous shrubby annual, 1-3 m tall, vegetative parts covered with short downy hairs; taproot long, strong, with many well-developed lateral roots, and numerous much-branched, lobed nodules up to 2.5 cm in diam. stems to 2 cm in diam.; leaves simple with minute pointed stipules; petiole short, about 5 mm long with pulvinus, blades linear elliptic to oblong, entire, 4-12 cm long, 0.5-3 cm broad, bright green; inflorescence a terminal open raceme to 25 cm long with very small linear bracts; flowers showy, small with 5 hairy sepals, shortly united at base, the lobes pointed, with 3 lower sepals united at tips, separating in fruit; petals deep yellow, the standard erect, about 2.5 cm in diam., rounded, sometimes streaked purple on dorsal surface, the wings shorter and keel twisted; stamens 10, almost free to base, 5 with short filaments and long narrow anthers and 5 with long filaments and small rounded anthers; fruit an inflated pod about 3 cm long, 1 cm wide, grooved along the upper surface, with a short pointed beak, light brown when ripe, several seeded, softly-hairy; seeds numerous, small, flattened, dark-gray to black, loose in the pod at maturity, 33,000 seeds per kg. Fl. July-August in Rhodesia.

Germplasm

Of several well-recognized types, best known in Pakistan are 'Madaripur' and 'Serajgnaj', the first one considered best, having creamy-white fibers of good strength, relatively free from dirt. There are cvs for different rainy seasons: 'Bhadai san', May, June-Oct., Nov.; 'Rabi san', Oct., Nov.-Feb. 'Somerset' is a good cv in Rhodesia. In India kharif and rabi sunnhemps are known. 'T6' is day neutral. 'Cawnpore 12' proved cv of 'Kharif sunn' of India, is superior in yield to all other types, although it is a longer growing cv requiring 2-2 1/2 months longer than 'Beldanga Early'. It is resistant to stem-break disease. 'Ullapora', a rabi variety, is superior in yield and quality. 'Tropic Sun' is resistant to root-knot nematodes. Its seeds and forage are nontoxic in laboratory tests and feeding trials (Rotar and Joy, 1983). Assigned to the Hindustani Center of Diversity, sunnhemp or

cvs thereof is reported to exhibit tolerance to disease, drought, insects, laterite, nematodes, poor soil, slope, virus, and weeds. (2*n* = 16).

Distribution

The origin is uncertain, but is believed to be native to India and Pakistan. Now cultivated throughout India (from the foothills of the Himalayas to Ceylon), Pakistan, in Uganda and Rhodesia, and in the western Hemisphere (e.g. Brazil) where it was introduced early in the 19th century.

Ecology

Sunnhemp is the fastest growing species of the genus and is very effective in smothering weeds. Almost any well-drained soil is suitable for the kharif crop. Sunnhemp grown during the rainy season is utilized mainly as a green manure, the fiber not considered of good quality. For fiber sunnhemp is grown on fairly light well-drained soils that retain sufficient moisture during the growing season. Sunnhemp is a short-day crop, but vegetative growth is favored by long days, although seed set may be poor. Although tolerant of drought, sunnhemp has low tolerance to salt and frost. Ranging from Cool Temperate Steppe to Tropical Very Dry through Tropical Wet Forest Life Zones, sunnhemp is reported to tolerate annual precipitation of 4.9 to 42.9 dm (mean of 29 cases = 14.9 dm), annual mean temperature of 8.4 to 27.5°C (mean of 29 cases = 22.5°C), and pH of 5.0 to 8.4 (mean of 24 cases = 6.2).

Cultivation

After plowing, seed is broadcast by hand or a device consisting of a canvas bag containing the seed with a blower attached. Then the land is cross-plowed. Seed is sown at different rates at different times depending on the use of the crop. In India seed is broadcast for fiber at a rate of 96 kg/ha under dry growing conditions, and less on irrigated fields. In Pakistan seed is sown at rate of 120 to 240 kg/ha. The heavy seed rate insures upright erect stems which help to smother weeds, produces a finer fiber and increases the yield. Height of stalks in crops varied from 1.15 m to 1.75 m (to 2 m), with an average thickness of 1.2 cm about the middle of the stalk. Seed is sown in Africa in late Nov. and Dec., even as late as Jan., except for weeding, which is usually not necessary if the land has been well prepared; no cultivation is required. Sunnhemp is a dryland crop. Where irrigated, furrows are opened in fields separating them into small plots. If there is no rain after sowing, field is irrigated along these furrows. Crop is irrigated once in 10-15 days, lightly compared to other crops, like tobacco and chilies. Too much moisture is harmful during the first 2 weeks after germination. Seeds germinate rapidly. In about 3 days seedlings appear above ground and soon form a thick cover. No manure is applied. Sunnhemp is often grown as a green manure, in rotation with tobacco, vegetables, dry grains, rice, corn, cotton, also sugar cane, pineapples, coffee, and orchard crops.

Harvesting

In some areas plants are harvested at the flowering stage, (100-108 days). In Rhodesia the crop is cut when stems have turned yellow along the major portion of their length. If grown for seed, plants are harvested after seed are well set, and before pods are dry, so that no seed is lost during cutting and bundling prior to threshing. In Pakistan crop is harvested when pods are ripe. Harvesting at flower stage gives a finer fiber, but profit obtained from the seed crop is thereby lost. There are no significant differences in strength and quality of fiber obtained from plants retted at flowering time and those retted when seeds are fully mature. With kharif crop it is difficult to secure both fibers and seeds from the same crop, because by the time pod ripens, cold weather has set in, and hard stems do not ret well. Plants are cut with knives or pulled and allowed to remain in the field for 1 or 2 days until dried leaves fall off easily. Stalks are then tied into bundles and retted for 4-6 days. However, in Rhodesia, 10-14 days are required during July, 8-9 days in August and 5-8 in September-October. The number of days required for retting depends on water temperature, locality, time of year, weather conditions, depth and source of water, thickness of stalks, and quantity of straw in relation to volume of water. Cement tanks are preferred for retting, but earth pits, dams, weirs, streams, and backwater pools of rivers are also used. Shallow water from 1-1.3 m deep is satisfactory. If more than one ret is to be carried out in a pool, sufficient flow of water must be maintained to prevent fouling the water, which discolors the fiber. Four or five men are required to remove and stack one ton of straw per day. Bundles are stood on end (15-20 placed with butts on ground at a sufficient angle to permit air circulation in all directions). In this way the straw dries in 1-2 weeks. By standing each bundle up and fanning out the butts, drying time is reduced to 4 days. By leaning bundles on each side of a rack, drying time is reduced to 3-4 days. Various machines are used to decorticate the straw. A 6 h.p. engine is minimal for economical and speedy decortication. After the fiber is stripped from the stalks by hand, it is washed and hung over bamboo poles to dry in the sun. Cut straw with a yellowish tinge requires 10 days to 3 weeks to bleach out sufficiently so as to have a fiber of a satisfactory color. Stems cut while green will bleach out when exposed directly to the sun but have to be turned at least twice. For seeds, a crop is allowed to stand until pods are fully ripe. Stems are cut close to the ground and left in the field to wither for a few days, reducing the retting period for fiber extraction. In humid districts in Ceylon this cannot be done since the fiber deteriorates. After all leaves are removed, stems are bundled and stored for additional drying. They are then threshed by beating small bundles held by hand against a plank, placed in a sloping position over a threshing mat, and pods separated. Dried stems are then ready for retting.

Yields and Economics

Handweeded South Carolina material given ca 20:25:50 NPK/ha yielded ca 12.5 MT DM/ha, with ca 40:55:100 NPK/ha yielded ca 13 MT DM/ha, with ca 60:80:150 NPK/ha yielded ca 14 MT DM/ha. Corresponding unweeded yields were ca 9, 10, and 11 MT DM/ha (White and Haun, 1965). Seed yields run from 500 to 1000 kg/ha (to 2470 kg/ha according to Rotar and Joy, 1983). Average fiber yields are 560-900 kg/ha. In Rhodesia 330 kg line fiber/ha; in Pakistan 500-600 kg/ha. Strength of cordage fiber of sunnhemp is 185 kg, as compared to 157 kg for cotton rope, 132 kg for hemp and 102 kg for coir. Fiber elements are easily separated with sodium hydroxide

solution or chromic acid. Extracted fiber is about 0.5-1.0 cm long, with an average diameter of 0.03 mm, among the broadest of bast fibers. World production of sunnhemp is 130,000 MT, principally produced by India, Brazil, West Pakistan. Sunnhemp exported from Calcutta is classed as Benares, Green or Raigarh hemp or Bengal hemp. There is a keen demand for Jaffna sunnhemp stems because local fishermen consider it superior to Indian sunnhemp fiber which is only purchased when Jaffna fiber is short. A hectare of crop was valued at 120-180 rupees depending on the quality. Fiber was valued at ca 60 rupees/kg, but was rarely sold because of its value to the fisherman. India grows about 360,000 hectares of sunnhemp annually, producing between 80,000 and 100,000 MT fibers, with about 20-30% being exported to the United Kingdom, United States, and Belgium.

Energy

DM yields as high as 7 MT/ha are reported in as little as 60 days along with N-fixation of 150 to 165 kg/ha (Rotar and Joy, 1983). Duke's phytomass files suggest yeilds of 4-5 MT/ha, but as indicated above, yields of 9-14 are possible with weeding and fertilization. If the crop is grown strictly for fiber, all the residues may be used for energy and mulch. Or one can extract 160 to 336 kg protein/ha (cf. 186 for *Sesbania sesban*, Jadhave et al, 1979).

Biotic Factors

Being a leguminous plant, sunnhemp is cross-fertilized by bees. It is attacked by many fungi: *Alternaria crotalaticola, Aspergilla versicolor, Ceratocystis fimbriata, Ceratostomella fimbriata, Cercospora canescens, C. crotalariae, C. demetrioniana, Chaetomium globosum, Cladosporium herbarum, Colletotricum crotalariae-junceae, C. curvatum, Corticium solani, Corynespora cassiicola, Curvularia penniseti, Dactuliophora tarrii, Fusarium acuminatum, F. equiseti, F. lateritium, F. moniliforme, F. oxysporum, F. scirpi, F. undum, F. vasinfectum, Gibberella fujikuroi, Leveillula taurica, Macrophomina phaseoli, Microsphaeria diffuse, Mycosphaerelia pinodes, Myrothecium roridum, Nematospora coryli, Penicillium wottmanni, Periconia epiphylla, Phyllosticta crotalariae, Sclerotium rolfsii, Sphaerella crotalariae, Synchytrium phaseoli-radiati, Thielaviopsis basicola, Uromyces decoratus.* The following bacteria also infect sunnhemp: *Bacillus megatharium, Pseudomonas cyamopsicola, Ps. syringae, Ps. viridiflora, Xanthomonas patelii, and X. vignicola.* The following viruses have been isolated: alfalfa mosaic, alsike clover mosaic, bean chlorotic ringspot, bean mosaic, bean necrosis, Brazilian tobacco streak, chlorotic mottle, mosaic (*Marmor vignae* var. *catjang*), mosaic, and witches broom. *Striga asiatica, S. hermonthica,* and *S. lutea* are parasitic on sunnhemp. Black beetles are serious pest in Rhodesia. The two most important and serious insect pests are the sunnhemp moth (*Utethesia pulchella*) and the stem borer (*Enarmonia pseudonectis*). Pod borers lower seed production. Among the nematodes are *Anguina* sp., *Aphelenchoides* sp., *Ditylenchus* sp. *Helicotylenchus canescens, H. cavenessi, H. dihystera, Heterodera glycines, Meloidogyne hapla, M. incognita acrita, M. thamesi, Peltamigratus negeriensis, Pratylenchus brachyurus, P. coffeae, P. vulnus, Rotylenchulus reniformis, Rotylenchus coheni, Scutellonema clathricaudatum, Trichodorus* sp., *Tylenchus* sp., and *Xiphinema longicaudatum.*

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last update July 8, 1996

100-Year Drought Is No Match for Organic Soybeans.

Scientific Trials at The Rodale Institute Give Hope to Farmers Everywhere

KUTZTOWN, Penn., (November 8, 1999) -After one of the worst droughts on record, the harvest for many farms in the U.S. has been a disaster. One farm is celebrating, however. "Despite a 100-year drought, the yield from our organic soybeans is outstanding," says Jeff Moyer, Farm Manager at The Rodale Institute's Farming Systems Trial®) (FST) in Kutztown, Pennsylvania. Using replicated plots the trial compares highly productive, intensive soybean systems under conventional and organic management. Figures just released show yields of 30 bushels per acre from legume-based organic soybeans compared to only 16 bushels per acre from conventionally-grown crops. Improved soil quality under organic management is credited for the high performance of Rodale's organic crops during this year's unusual drought.

"These are very significant findings for farmers around the world," says Moyer. "Our trials show that improving the quality of the soil through organic practices can mean the difference between a harvest or hardship in times of drought," he said. Pennsylvania was just one of fourteen states declared drought disaster areas by the U.S. Dept of Agriculture Secretary, Dan Glickman this summer. With only 4.4 inches of rain in Kutztown from June through August compared to an average of 13.4 inches in normal years, The Rodale Institute's organic soybean yield is even more impressive.

Initiated in 1981, the FST® is currently funded by the Rodale Institute in cooperation with United States Department of Agriculture - Agricultural Research Service (USDA-ARS.) The trial's manure-based organic soybean plots also performed well above the level of conventional plots, achieving 24 bushels per acre. In a non-drought year, yields for both conventional and organic would be expected to be 40 bushels per acre. "Over time, organic practices encourage the soil to hold on to moisture more efficiently than conventionally managed soil," says Moyer. "The higher content of organic matter also makes organic soil less compact so that root systems can penetrate more deeply to find moisture." In addition, organic practices reduce nitrate leaching and erosion.

As Tennessee farmers abandon their worst soybean crops since 1956,

and communities in Kenya and Somalia brace themselves for a drought-based famine, The Rodale Institute's results are a positive indication that adopting organic practices can help avert future crop failures around the world.

The Rodale Institute is a nonprofit charity located in Kutztown, Penn. The Institute shares its expertise on organic/regenerative farming methods with people worldwide to achieve a regenerative food system that renews environmental and human health. 'Healthy Soil, Healthy Food, Healthy People®' has been the Rodale Institute's message for the past fifty years. Funded in large part by donations from individuals, government agencies, private foundations and corporations, the Rodale Institute continues to promote soil quality practices to farmers worldwide.

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It's such a good feeling when spring finally comes. Our whole neighborhood is full of color. Even here, by the office in downtown Eugene, Oregon, climbing roses along the building are blooming, the ivy is starting to cover the window and the figs I planted several years ago have new leaves on them.

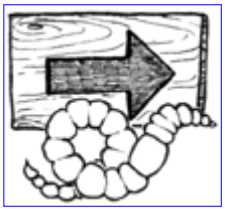
Spring's also the busiest time of year at Worm Digest. Not only is the phone ringing, ringing, ringing, but the emails are pouring in. People want information and advice on getting their composters running smoothly again.

By February, we started to pull the pieces together for another earth day celebration and our Children's Worm Bin Workshop. This year, once again, we served up one hundred small worm bins and helped children paint them, prepared bedding together then taught them a lesson on worm care and feeding.

We're grateful to Roosevelt Middle School's woodshop students and their instructor, who managed to assemble one hundred small plywood bins in only two weeks! I visited the woodshop the second week, and saw students working at eight different stations, from the chop saw where they cut the lids, sides and bottoms, to assembly, to sanding and other finishing touches. These were truly some fine worm bins!

Our earth day booth was an equally busy place. We had a lot of fun and saw some real masterpieces being painted! The front table was hopping with adults stopping in to ask compost questions and to look at worm bin critters with a magnifier. Parents brought their children in to paint. Our volunteers hopped from table to table, refilling trays of bright colored paints.

First Time Visitor?



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(Thanks to all of the sponsors listed at the top right of this page, who helped make this event happen.)

Then, just two weeks after earth day, author Amy Stewart came through town to promote her new book, The Earth Moved: On the Remarkable Achievements of Earthworms. We held a two-hour event together at Down To Earth, our local organic garden store, and enjoyed the company of forty or so avid gardeners and composters in attendance.

Now that these two events have come and gone, I'm happy to be spending time again writing, answering the phone and enjoying spring. I hope your spring is just as beautiful where you live.

-- S. Zorba Frankel, editor

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by S. Zorba Frankel

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Submitting your site to the tour will bring you visits from people like yourself, those interested in vermicomposting and vermiculture.

Once you submit your site to the tour with the form below, you will be emailed the information necessary to add specific customized html code (below) to your pages. After you have accomplished this easy task then your site will be added to the tour if it meets our criteria.

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target="_top">Prev</a>] [<a href="--webringurl--?ring=--ringid--;id=--id--;next"
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The purpose of this website is to provide accurate information about earthworms and vermicomposting through photos, information and resources. My "Worm Thoughts" Blog gives insight into how I care for my own worms and offers information on worm behavior. I raise Redworms (*Eisenia fetida*) and European Nightcrawlers (*Eisenia hortensis*) and share my experiences with my worms, covering a wide range of topics.

If you participated in my Worm Bin Polls, the results are now posted! Visit The "How and Why" of Worm Bins to read about the poll results.

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An award winning teacher and seasoned performer, Stan has traveled throughout the country since 1987 performing a repertoire of original and old favorite Earth Songs at schools, museums, libraries and festivals. He is a proven crowd pleaser with both children and adults.

Stan excels at providing the big picture and the context needed to understand complex environmental problems. With a Bachelor's degree in Education and a Master's in Biology, Stan taught physics, biology and chemistry for eleven years. His music, reflecting the Blues of Kansas City and the country influences of his youth, is a wonderful vehicle for memorable learning.

Stan's most recent award is the H. Clark Gregory for Outstanding Grassroots Efforts to Promote Composting from the US Composting Council. Other honors include the 1976 Junior High Science Teacher of the Year for the Greater Kansas City area, Missouri Waste Control Coalition ('93), the Sierra Club ('94), the US EPA ('95) and was the first non-Kansan honored for his work in Kansas by Kansas Governor Graves in 1997.

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Chapter 3

The First Agricultural Path

THE original strength of both China and Rome was that of superior peasant-agricultures. China preserved hers as her foundation almost to the present day. Rome abandoned hers as the source of social strength and stability, and in her fall left wide-spread desolation as the final monument of her methods.

We will first take the unique story of the agricultural path of China through its forty centuries of existence. It has recently been admirably told in the English language by Dr. Mabel Ping-Hua Lee in *The Economic History of China, with Special Reference to Agriculture,* 1921, issued as Volume 99 of the Columbia University of New York's *Studies in History.*

The agricultural history of China began in the remotest past some twenty centuries before that of Rome. It began with the creation by the Chinese sages of a practical unit of agriculture and social structure, which penetrated Chinese history as a practice and ideal up to modern times. This was known as the system of the Tsing Tien.

1	2	3
8	9	4
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Tsing Tien means the nine fields, made by the division of a large square into nine

smaller squares. This was devised by the sages as the primary division of land.

The eight outer squares were given to eight families for their individual use; the ninth or central square was reserved for the government and was worked in common by the same eight families.

It was a device both of family individualism and co-operation. "The advantages of the system were thus enumerated: 1. Saving of expense; 2. Unifying of customs; 3. Improved production; 4. Easy exchange of commodities; 5. Mutual production; 6. Close social relations; 7. General co-operation."

The measurements of the square fields were standardized, so that any area could be marked off without ridges or baulks and the loss of land they entail. Moreover, except for the buffalo to draw the plough, the donkey as a beast of burden, and the pig, which can live without pasture, few domestic animals were kept. The cultivation of animals, therefore, never became the rival of the cultivation of crops. "The subject of conversion into pasture lands may be wholly left out of consideration in a study of the history of Chinese land conditions."

Fields vary in fertility, even those in close conjunction. This was well known to the Chinese with their minute local knowledge of their land, so local modifications of the principle were made. So also by adoption of children and the standardized measurement of land, adjustments were made to balance large and small families.

The system included a payment of one ninth to government. This may be compared to the division in the *Laws of Manu*, Book 7, 130-2, and Book 118, in which it is stated that the King shall take one sixth, one eighth or one twelfth of the crops, and one sixth of the other produce. Significantly, at times of urgency, he could take one fourth.

"The whole history of the government administration of agriculture in China coincides with the history of the Tsing Tien system," writes Dr. Ping-Hua Lee. "Its vicissitudes, its crises and its epochs were timed by the abolition or re-establishment of the system ... It is fortunate for the economic historian that the Tsing Tien system is coincident with China's political history."

Chinese history is then of the simplest. At times of peace the system and its partners, the peasant-proprietors, flourished. At times of great government urgency the system waned or was even temporarily abolished.

The history of the Chinese has been singularly, though by no means entirely, peaceful. Their wide dominion came to them largely owing to the attraction which their superior civilization had upon other peoples. "They have none of the characteristics of a warlike race, and their triumphs over less cultivated peoples have been gained rather by peaceful advance than by force of arms." (Sir Robert Douglas, *China.*) The cause of this peacefulness was undoubtedly their excellent cultivation

and their continued preservation of the fertility of the soil. They did not become land-hungry as did the Romans.

Chinese agriculture is credited with beginning forty-six centuries ago. In the reign of Emperor Yao (2357-2261 B.C.) -- we return to Dr. Ping-Hua Lee -- "the making of canals, connecting the ditches in the fields with the rivers, and the deepening of the rivers for the purposes of drainage, inaugurated the immense systems of canals found in present-day China."

The Emperor Yao was followed by the "Golden Age" of Chinese history. Here it may be said that a golden age is so common in the traditions of many peoples that one may conjecture that it may one day be found by research that it had a material basis in a widespread period of excellent agriculture. There is already evidence of this. Mr. O. F. Cook, of the U.S.A. Department of Agriculture, began a remarkable article in the National Geographic Magazine of May, 1916, with these words: "Agriculture is not a lost art, but must be reckoned as one of those which reached a remarkable development in the remote past and afterwards declined. The system of the ancient Peruvians enabled them to support large populations in places where modern farmers would be helpless." Sir William Ramsay, in the November number of 1922 of the same magazine, brought forward similar evidence of a wonderful agriculture in ancient Asia Minor; Professor Vavilov, of the University of Leningrad, has established the remarkable ancient agriculture of Afghanistan and North-western India; Sir William Willcocks has championed the existence of an ancient Bengal agriculture comparable to that of the China of the Emperor Yao; and the list could be greatly extended. There is certainly evidence of the reality of a Golden Age. It can be thought of as a great agricultural period, and in the main free from the wars, migrations and civil disturbances which take their origin in a hunger for land and its products.

No country is left to the uninterrupted enjoyment of a golden age. In the history of China, as well as that of India and Europe, a chief disturbing factor has been the aridity of the continental lands mainly lying to the north of the great desert belt of the Gobi, Lopnoor, Taklamaken, Kisyl-Kum, the Persian and Arabian deserts.

It is not possible here to enter into the causes of aridity; to debate as to how much was due to climate and how much due to the destruction of forests by fire and axe by pastoral peoples and those that practice shifting cultivation. The effect of droughts occurring in arid countries can, however, be graphically realized by a recent calculation made in the arid regions of New South Wales, Australia. A rainfall of 20 inches upon a square mile of land will keep 600 sheep; one of 13 inches reduces the number to 100; one of 1 inch to but ten sheep. In dry periods the resulting starvation of pastoral peoples living upon their flocks can only be avoided by migrating to food-giving areas.

The pastoral peoples and peoples of shifting cultivation in Mongolia to the north of the Gobi Desert were the section of the arid peoples who had the chief and most

continued effect upon the history of China. They appear as the invaders of her territory under the name of the Hun-yu about four centuries before the Emperor Yao, and they included the Manchus, whose dynasty came to an end in A.D. 1911. They were in general called the Tartars by Chinese historians.

The Chow dynasty (1122-256 B.C.) saw the maturity of the Tsing Tien system, with the land and its taxation apportioned to careful estimations of soil fertility and the working capacity of the family, to which each portion of the land was allotted.

The later period of the Chow dynasty, from 659 B.C., was one of nominal authority. The empire was broken up into the "Warring States," some of which had Tartar dynasties from the west and north. One of the seven principal states was that of Chin. In 350 B.C. the Duke of Chin created Shang Yang his minister of state. Shang Yang saw that in Chin land was plentiful but the population was scarce. He adopted two methods to improve and enrich the state. He regulated the rivers and by irrigation made the land safer for agriculture, and then he invited farmers from more crowded states to migrate to Chin. To tempt them he allowed them to take up as much land as they could cultivate, regardless of the Tsing Tien system; in other words he abolished that system and gave the land as private property to those who were willing to cultivate it. Having established agriculture by means of the new settlers, he freed the native men of Chin from work upon the fields and made them into an organized army. "Within a period of several years the state became rich and the army strong." Chin became the strongest of the Warring States.

About a century later Chen, to become known as Chin Chi Huangti, meaning the first Chin Emperor (246-202 B.C.), became the duke of Chin. He used his army to such effect that he reunited China.

Impressed by the results of the land system of Shang Yang, Chin Chi Huangti abolished the Tsing Tien system throughout the empire, and land was made private property to be bought and sold freely. This enabled him to collect peasants who had lost their land and set them to work on the stupendous achievement by which he is chiefly known, the building of the Great Wall of China to shut out the Tartars. The wall extended along the frontier for fifteen hundred miles. He also followed Shang Yang in instituting irrigation works; he built roads; he erected a magnificent capital; in short, upon the capital of the labour which he had forced from the fields, he erected public works on an immense scale. His was the first great departure from the Tsing Tien system.

But before the end of his reign this fevered capitalization had eaten up much of the real wealth of the people. A contemporary recorded that the people became so impoverished that "the men worked hard on the farms, but were unable to get enough to eat. Girls spinning could not get enough to wear. Therefore the people became dissatisfied with the Chin dynasty."

Upon the death of this masterful emperor, rebellion broke out, his son was slain, and

the Han dynasty (202 B.C.-A.D. 220) was established. Then ensued a long struggle between the large landowners who opposed and the imperial ministers who desired the restoration of the Tsing Tien system. "Tung Chung Shoo, in his petition for the limitation of landholdings, reveals to us the condition of the poor. They were so reduced that they lost all their holdings to the rich, so that it was a common saying of the day -- 'that whereas the land of the rich extended from fields to fields, the poor had not enough to accommodate the point of an awl.' Landlords, being given a free hand, rents went as high as fifty per cent of the produce."

In these critical times it seemed as if China would be permanently forced off the first agricultural path on to the second, that of capitalistic farming. The fate of the peasantry hung in the balance. The struggle was severe; the soil, lacking its accustomed tendance, degraded with the peasants and much of it went to waste; great numbers of the peasants died of starvation. At one time, continues Dr. Ping-Hua Lee, it was "estimated that only 20 to 30 per cent were left. This reduction of population was itself a remedy, for there was land, left ownerless, which could be given to the poor and to returning wanderers ... Every encouragement was given to agriculture by the extension of irrigation; the poor were relieved through tax exemptions and provided with lands, seeds and food. Even land belonging to the ruling house and attached to its imperial ancestral temples were thrown open to cultivation." By these efforts of an administration inspired "to govern the country, not with the interests of the few, but with the necessities of the many," the peasant-family cultivation was restored. A period of grandeur followed, in which all the provinces south of the Yangtze River joined those to the north, and the empire itself was extended over Mongolia and westward to the Caspian Sea, at the time when Rome had attained the widest extent of her dominion. Parthia alone separated the two empires.

The Han dynasty came to an end and was followed by a long period (A.D. 220-590) of divided states and partial conquests by Tartars. The Tang dynasty (A.D. 618-905) restored the unity and the fame of China. It was followed by the Sung dynasty (A.D. 960-1276). Both dynasties supported the Tsing Tien system against the rich who had "eaten up" the land in the long period of divided states. Emperor after emperor strove to check and reduce the large estates of the wealthy. Their efforts succeeded when fertility gave prosperity, and the fields, worked in common for the government, supplied the needed revenue. But when drought, flood, imperial expense in combatting the Tartars or due to extravagance, degraded the soil, the opportunities for the rich to take over the lands of the poor recurred. Both dynasties, after centuries of fame and prosperity, came to an end at times of increase of the large estates and corresponding distress amongst the peasants.

So the inner history of China continued, fluctuating according to the fertility of the soil and the adherence of the government to the principles of the sages.

The next rulers of China were Tartars, the great conqueror, Jenghiz Khan and his descendants. Both they and their predecessors in Northern China, the Kin, were vigorous people; both were profoundly impressed with the principles of the Chinese

civilization; both reorganized agriculture on the model of the Tsing Tien system.

The Chinese Ming (1368-1643), who expelled them when their original vigour had decayed, were at first the champions of the Tsing Tien system. Later, before the end of their dynasty, they and their officials became corrupt, levied supertaxes for their own benefit upon the peasants and despoiled the land. The Ming were overthrown by a small body of Tartars from Manchuria, who constituted the last dynasty of China, that of the Manchus (1644-1912).

The Manchus modelled themselves upon Chinese methods, to which they gave their northern energy. "Within sixty years from the beginning of their dynasty, they had restored prosperity and contentment to the realm."

They restored the cultivation of the land by peasant families, but they did not restore the payment of revenue from the central field. The Ming had introduced other taxes, poll tax and super-taxes. The Manchu imposed a single fixed tax upon land, at one time said to have been only one twentieth of the gross product. It was paid partly in kind and partly in silver.

As their dynasty continued, the fame of China in Europe increased. Marco Polo had already sung the praises of the Chinese, their politeness, their cheerfulness, their use of every part of their land, and their beautiful cities such as Hangchow, which other travellers also acclaimed as the loveliest and greatest in the world.

It was the wealth of these cities that most attracted the merchants and sailors of Europe. The land route across Asia being blocked by the Turks, the sea route was discovered. On their part, the Chinese had no desire to trade. Their vast and rich country gave them all they needed; their civilization was complete; they desired no change. But the day of intrusion into their self-sufficiency came. In 1516, a Portuguese trading vessel sailed up the river to Canton and startled its inhabitants with a salute of guns. The influence of the western traders had begun. Later came the enforced opening of certain ports, the establishment of embassies in Peking, and the permission for foreigners to travel in any part of the empire.

Wars and quarrels with Europeans led to the exaction of indemnities to be paid in money, and, after the Taiping rebellion in 1860, all Chinese taxes, including the tax on the land of the family cultivators, had to be paid in silver and not in produce. The unique agricultural path of China, embodied in the Tsing Tien system, came to an end.

Such, in brief outline, is the story of the most aged dominion of the earth. Other empires rose and sank; she alone survived. And one reason of her survival was that, throughout her long history, she preserved as a principle, sometimes strained to the breaking point, the partnership of the peasants and soil which her sages systematized.

We now turn to the story of the Roman agricultural path, which failed to preserve the

peasantry, through whose strength and superior agriculture Rome originally rose to greatness.

Chapter 4

The Second Agricultural Path

THE original strength of Rome, like that of China, was that of a superior family-agriculture.

The evidences of the quality of the early agriculture of the "Old Latins" (*prisci Latinii*) exist in the traditions of the later Romans, but not in actual history as in China. The traditions, however, have been confirmed by the revelations of modern excavations.

These excavations were carried out by Monsieur R. L. la Blanchère and described by him in the *Memoires* of the *Academie des Inscriptions et Belles Lettres* in 1893.

Mr. Tenny Frank conveniently summarizes them in his well-known *Economic History of Rome,* 1927. Monsieur de la Blanchère exposed, he writes, "numerous relics from that remarkable period in Latium, traces of drains, tunnels and dams too little known ... By diverting the rain waters from the eroding mountain gullies into underground channels, the farmer not only checked a large part of the ordinary erosion of hillside farms but also saved the space usually sacrificed to the torrent-bed. It would be difficult to find another place where labour had been so lavishly expended to preserve arable land from erosion." In addition to underground channels, there were dams "of finely trimmed masonry ... largely made of huge blocks weighing half a ton each ... It is impossible, after surveying such elaborate undertakings, not to conclude that Latium in the sixth century was cultivated with an intensity that has seldom been equalled anywhere."

The soil itself was rich but not deep. It had at one period been enriched by the volcanic ash of more than fifty craters, long extinct, which can be found within twenty-five miles of Rome.

Thus the heroism of Rome began with an heroic agriculture upon a favoured soil, comparable on a small scale to that of the great engineering agriculture of the ancient Peruvians in the inhospitable valleys of the Andes.

Roman literature itself began with writers upon agriculture some four centuries later. These writers, though they constantly praise the virtues and skill of their ancestors, do not include -- or such records have been lost -- the engineering quality of their cultivation. The elder Pliny repeated the tradition of the populousness and prosperity of Latium of that period, its fifty flourishing villages, and modern excavations of their sites have confirmed his description. The Latin people were so strong and healthy, he

asserts, that they had no need of physicians. Their high quality of manhood, exemplified by their military invincibility and their devotion to the soil, left an ineradicable impression upon their descendants; and the decadence of the family-farmers, which was seen in their own times, became the constant lament of the writers and the no less constant but useless endeavours of Roman statesmen to avert it and to restore the traditional virtues.

When, in the early days of her history, Rome fought for Latium, the farmers proved themselves sound warriors. Then began the magic story of her wide dominion. War followed upon war, and it was the military qualities of the intensive farmers in particular that brought about the triumphs of the State. In this they contrasted radically with the Chinese intensive farmers, who were exempted from military duty. In the frequent call to arms, occurred the first departure -- no doubt an enforced and unavoidable departure for so small a state -- from the primary partnership of the peasants with the soil. The soil suffered from the absence of the able-bodied men; its culture was left to the young and the old, while they were away. War was antagonistic to the soil's fertility.

There came the second Punic War (218-210 B.C.), and the invasion and devastation of Italy by one of the world's greatest commanders, Hannibal of Carthage. When, finally, Hannibal was expelled by the victorious farmers, the Roman senators were faced with a crisis similar to that which faced the early Han emperors and their ministers, after the building of the Great Wall and the abolition of the Tsing Tien system.

Many of the farmers had lost their lives and yet more had seen their farms destroyed in the tragic seventeen years. Was Rome to be restored to the first path of agriculture, that of peasant family farming, or was she to enter upon that of capitalistic farming? The senators or statesmen of Rome had no Tsing Tien system of the Chinese sages, no separation of agriculture from militarism as taught by the Hindu sages, to guide them. They earnestly desired the restoration of the peasant families. But they desired it for military reasons rather than for agricultural reasons. The military value of the farmer-warriors had never shown to greater advantage than against the terrible genius of Hannibal. Its restoration appeared the chief hope for the future to the Roman statesmen faced by immense new military responsibilities. They were committed to dominion and war.

But, great as was their desire for a restoration, it was beyond their grade and will. Rome had grown greatly in wealth and territory through the overthrow of her powerful rival. In the place of the farmer-warriors, who had lost their lives or land in the war, there were numbers of slaves from agricultural countries, to be bought cheaply by men with capital. Moreover, as a fundamental cause overriding all subsidiary ones, was the state of the soil itself. The soil had generally lost the high grade of fertility, which is necessary to small intensive farming; farms were in disorder; many were abandoned. Roman Italy's soil was in short in the same condition as was that of China after the death of the Emperor Chin Chi Huangti, the builder of

the Great Wall.

In such cases degraded arable land, no longer yielding sufficient return to repay the labour spent upon it, can, for more immediate profit, be better turned into pasture than be restored to its original condition; it can be more easily aggregated into large estates requiring less intense personal labour and capable of being worked by cheap hired or slave labour. In Italy the slave gangs offered cheap labour in such abundance as to compare with that of modern agricultural machines. Feeding on the land and with the crudest living accommodation, the cost of their maintenance was minimal. Moreover, the success of the Romans in overcoming Carthage had won for her the cornfields of Sicily and those of a considerable part of Northern Africa, so that her urban populations could now be fed from overseas. This released much of the arable land of Italy for the profitable cultivation of the olive and the vine, and for the rearing of sheep, which, in view of the universal practice of wearing woollen clothes, had its especial value. The consequence was that the senators yielded to the pressure of events and allowed or encouraged capitalistic farming to take its course. The aristocratic families came to own nearly all the land, the seizure of which they legalized. "Since the aristocracy had given itself legal permission to buy out the small-holders, and in its new arrogance allowed itself with growing frequency to drive them out, the farms disappeared like rain drops in the sea," are the words of the famous historian, Theodor Mommsen.

The choice resulted in changes, which were to be repeated in more modern times in western peasantries and agriculture. Money, profit, the accumulation of capital and luxury, became the objects of landowning and not the great virtues of the soil and the farmers of few acres; small owners, striving to restore the fertility of their farms, fell into hopeless debt; the position of the moneylenders was reversed.

In the past that position was described by Porcius Cato in the following words: "Our ancestors considered and so ordained their laws that, while the thief should be cast in double damages, the usurer should make fourfold restitution. From this we may judge how much less desirable a citizen they esteemed the banker than the thief. When they sought to commend an honest man, they termed him a good husbandman, good farmer. This they rated the superlative of praise." (*De Agricultura*, Mr. F. Harrison's translation).

But now the positions were reversed. The moneylenders or bankers were no longer controlled, but grew in importance, as the good farmers, for all their efforts, failed to restore their farms, fell into irredeemable debt, surrendered their farms, and, unable even as labourers to compete with the slaves, added their numbers to the pauper population of the metropolis. Even those, who had been craftsmen and tradesmen, found little work, for they too met with the competition of the slaves, attached to the great families of the rich. So the chief material reason for family life, namely the continued work, generation after generation, upon the family land or at the family craft, was lost, and with it the ancestral virtues, morality and religion also vanished.

"The Equites, the upper middle class, were the great capitalists of the day," writes Lord Tweedsmuir in *Julius Caesar,* 1932. "They farmed the state rents and taxes, contracted for the armies, made fortunes in the slave trade, and controlled the banks. Usury was one of the main industries of the Roman world." Debt was general, but at the same time under the stimulus of capital and the opportunities which the provinces and trade offered to it, there was a period of immense material progress, comparable to that of the early part of the industrial era of modern times.

Meanwhile, the fate of Rome depended, as the fate of men depends, ultimately upon the fertility of the soil, from which they get their food and the chief raw materials for their manufactures. The story is one of notable advance in the newly conquered provinces, when the engineering skill and agricultural methods of the Romans were applied in place of those of less tutored peasants. Nevertheless, in spite of this, especially from the end of the second Punic war, a gradual loss of soil fertility, spreading outwards centrifugally from Latium and Italy to the provinces, took place. The one exception was Egypt. Egypt owed her fertility to the annual overflow of the Nile. That was beyond the influence of men. It may be conjectured that, together with the exceptional military and federative quality of the Romans, it was this perennial fertility of Egypt that gave to Rome her prolonged ascendancy.

The story of the gradual failure of fertility has been graphically described by Professor V. G. Simkhovitch in the thirty-first volume of the *Political Science Quarterly of the Columbia University,* 1916, in an article entitled "Rome's Fall Reconsidered."

He begins by collecting and quoting from the great Roman writers who were "quite conscious of Rome's progressive disintegration." The elder Pliny, for example, had no doubt about a chief factor in the degradation: "The large estates, the *latifundia,* were ruining Rome as well as the provinces." Seneca, one of the richest landowners, gave the same warning. Cicero, at an earlier time, reported the statement of the tribune Phillipus that "the entire commonwealth could not muster two thousand property owners."

Other writers stressed the moral corruption of the times. "What does ruinous time not impair?" wrote Horace, the poet. "The age of our parents, more degenerate than that of our grandfathers, make us even more worthless and we give birth to a still more vicious progeny. The great deeds of the Romans were the deeds of a sturdy farmer race, and these farmers' sons exist no longer." Columella, about A.D. 60, opposed a general opinion "that the soil, worn out by long cultivation and exhausted, is suffering from old age," and attributed its degradation to the enforced and indifferent labour of the agricultural slaves, and to bad farming generally. To those who saw in frequent wars the cause of the deterioration of the soil, Columella replied that, though fields may be laid waste by an enemy, the fertility of the soil is not taken away or wasted; it remains to respond to good cultivation, when renewed.

The degradation, according to these writers, began first in Latium itself, closest to and most able to feed the great metropolis of Rome. Varro noted bad patches and foul or abandoned fields in Latium, and two centuries later Columella referred to all Latium as a country where the people would have died of starvation, but for its share of Rome's imported corn.

"It seems to me," continues Professor Simkhovitch, after further quotations, "that the progressive exhaustion of Roman soil is completely established ... It was a long process and many were its stages."

At first the farm of seven jugera (a jugerum was 5/8 acre) was sufficient for a family; then, in bad times due to wars and the absence of the farmer-warriors, it was ill-worked, then over worked and overstocked to make up for lost time, when the survivors of the war returned. So deterioration began. Loans did not help. Debt, due to a single bad season, can be paid, but under conditions of progressive soil deterioration, however gradual, debt correspondingly increases until its burden becomes no longer bearable, and the land falls into the hands of the monied classes. This fate fell upon the small, intensive farmers of Rome. It was not due to the lack of agricultural knowledge. "Nothing could be more startling than the Roman knowledge of rational and intensive agriculture." It was not due to debt. The fact that debt began when the failure of the soil's fertility began was symptomatic, not causative.

The spread of the degradation of the soil was centrifugal, from Latium outwards. The Roman armies moved outwards from Latium demanding land; victory gave more land to the farmers; excessive demands again brought exhaustion of fertility; again the armies moved outwards.

In her early days, says the professor, Italy was famous for her wheat; Greece, preceding her in her degradation of the soil, had imported wheat from Italy. Yet, after her seizure of Sicily from the Carthaginians, Italy depended mainly upon Sicilian fields for wheat. Thus the ring of movement in search of food widened outwards.

"Province after province was turned by Rome into a desert, for Rome's exactions naturally compelled greater exploitation of the conquered soil and its more rapid exhaustion. Province after province was conquered by Rome to feed the growing proletariat with its corn and to enrich the prosperous with its loot. The devastations of war abroad and at home helped the process along. The only exception to the rule of spoliation and exhaustion was Egypt, because of the overflow of the Nile. For this reason Egypt played a unique role in the Empire." Egypt was made a special imperial possession. It was carefully guarded. Not even senators or knights could visit it without the permission of the emperor, for, as Tacitus stated, a small force might hold Egypt and "by blocking up the plentiful corn country, reduce all Italy to a famine."

Sardinia, Sicily, Spain, and north-western Africa, as Roman granaries, were, like Italy, involved in the same process of exhaustion. Though the Romans were well

aware of the dangers of deforestation to the land, their hills were denuded of their forests. The abandoned land of Latium and Campania turned into malarial swamps; that in north-western Africa and in parts of Asia turned into deserts. It was not war that led to depopulation. After the first increases in the numbers of the people due to the material progress of the Caesarian Empire, depopulation set in and proceeded throughout the longest period of peace Rome ever enjoyed. It was due to the loss of the fertility of the soil.

The "inner decay" of the Empire "was in the last analysis entirely based upon the endless stretches of barren, sterile, and abandoned fields of Italy and its Provinces ... Italy's great historians marvelled how sections of Italy, that in their times were almost entirely deserted, could in former days send forth legion after legion of invincible warriors ... Egypt was the only province which maintained its population."

It was not the intention of Professor Simkhovitch to advocate a history based only on soil fertility or its loss; still less to ascribe the fall of the western empire of Rome to that sole cause. The causes of that great historical catastrophe were manifold, as also were those that preserved China through the ages from a like fate. No historian would presume to isolate a single cause, nor indeed attempt to surpass or even simplify the last sad chapter of Gibbon's monumental record of Rome's fall. It is sufficient to have shown that both empires suffered periods of disaster; both were subject to invasions and conquests from peoples who originally came from the same great arid belt of Asia; both strove, amongst other means of strength and recovery, for the establishment of an independent family cultivation of the soil.

Rome failed and, before her fall, as a last final effort to gain food for the empire, she bound the agricultural community by law to the soil, and thus left the heritage of serfdom to western Europe. China, on the other hand, recurred again and again to the restoration and strengthening of family farming, and succeeded, after each catastrophe in her history, in regaining her authority and in expelling or absorbing her conquerors.

The Roman Empire was an epoch of such grandeur of achievement and power that it has captured the imagination of men, yet it left desolation in its wake. The Chinese Empire was also one of great, though less dazzling, achievements. At the present time it still survives, though deeply involved in the tragic disturbances of modern civilization, which is forcing it to join up upon the catastrophic second agricultural path.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 2

Rome

Rome and its civilization constitute the progenitors of the civilized Western world; consequently, without a knowledge of Rome's relation to the soil, it would not be possible for us to extract from history the principles of reconstruction from the soil.

We have to study history, because in no other way can we tell what the Roman land was like and how it looked. History reveals that if, by some magic, we could transport ourselves back to the days of the early Latin farmers, we should see a picture of a well-populated countryside with the land divided up into a number of small farms, often not exceeding five acres in extent. As each small farm had to support a family, the farming, we should see, was intensive; in other words, each particle of soil would be in use, so that the fields appeared quite crowded with a variety of crops. The whole food of the family would come from the farm, and not only the food of the family, but that of some of its domestic animals. By day we should see the various members of the family hard at work upon the farm, the males -- and sometimes females -- busy upon the land itself, and the womenfolk in the home and dairy. We should see also a large number of villages with a pleasant light of prosperity shining upon them. Other things would also be there of great importance, soon to be described, some of which could be seen, and some found under the earth.

Then let us be allowed to look at the same land some five centuries later. The picture is now quite different. We should see but few villages and few small farms, and upon the farms we should see what farmers call foul fields and even land that was derelict. In place of the small farms we should see mainly orchards, vineyards and dairy farms. It would, indeed, be quite clear to us that the main object of this different form of farming was to supply fruit, grapes, olives, milk and cheese to people who did not work upon the farms or in the villages at all, but who lived in the proud, neighbouring city that had now become the chief city of all Italy and was soon to become the capital of the Mediterranean world. We should also see that these estates were no

longer worked by Latin farmers, but by quite a different sort of men, clearly not Italians, and men lacking the buoyancy and freedom of the older farmers. We should, indeed, have reason to rub our eyes, for some of these men, incredible though it might seem to us, would be shackled with iron and some even chained to each other while they worked. These were the slaves, some of whom were strong, fierce men and some weak and depressed. These two pictures we should see; the first would be that of family farming, the second that of capitalistic farming.

Transporting ourselves to a yet later date, we should see a third picture. The land is now swampy and derelict, and its most significant product swarms of mosquitoes, which caused the fevers that permitted only a few wretched men and cattle to scrape together some sort of livelihood and that visited, with lethal effect, the inhabitants of the great but waning city itself. This would be the picture of debased soil fertility.

Now let us see how history explains these three pictures.

Of the farming of their ancestors in Latium the later Romans had no history. Nevertheless, a strong tradition existed, and that tradition placed both farming and farmers very high. In the words of the elder Cato, to call a man a good farmer was in the past the best commendation, the highest praise.

Now this praise in the pages of *De Agricultura* must have been read a host of times without more than a general significance or regretful sentiment being attached to it. But modern discovery has shown that it had a very sound, practical significance. The high esteem of the men of ancient Latium for good farming and the facts concomitant with it were not sentimental; they have been summed up under these words: 'It is impossible, after surveying such elaborate undertakings, to avoid the conclusion that Latium in the sixth century (B.C.) was cultivated with an intensity that has seldom been equalled anywhere.' This is the statement of a modern authority. In short, *the tradition of the later Romans about the wonderful farming of their ancestors was not founded upon sentiment, but upon fact*. By the time of Cato and later writers, a good deal of sentiment had entered and a good deal of fact had slipped away. These later Romans knew that their ancestors had been great farmers, but they do not seem to have known the greatest part of their work. That has been revealed by modern investigators and particularly by the excavations of Monsieur M. R. L. la Blanchère, published in 1893 in *Mémoires présentes par divers savants à l'Académie des Inscriptions et Belles Lettres*. Professor Tenny Frank, the above-quoted authority in *An Economic History of Rome*, 1927, summarizes this remarkable paper, which can be itself read in the library of the British Museum. The excavations reveal that Latium was the home of a farming which it might well be said, has seldom been equalled anywhere. It was a farming related to the great farming of ancient Peru, the farming of Asia Minor in its prolific days, the farming in which Professor Vavilov researches, the farming of the Hunza, the farming indeed of many or even all great countries of the world in a time when farming reached a height from which almost all of them later fell so steeply as to have become oblivious to it.

Professor Tenny Frank begins his book on the economic story of Rome where it should begin, namely, in the soil of Latium. On the one hand, that soil was singularly rich, rich as the loess soil of the Chinese and the alluvial soil of the Egyptians were rich. It had not their depth, but it had the exceptional contribution of the ash of some fifty craters, which are within twenty miles of Rome. On the other hand, it was placed in a perilous situation if men were to neglect it. It was a wide band or plain, the Campagna, situated between the sea and the steep Alban and Apennine mountains. Upon these mountains rain at certain seasons fell heavily. When there were trees on the slopes, then the rain in its fall was broken by leaf, twig and branch into a spray before reaching the soil. Where the trees were cut down freely or where the slopes were too steep for them to grow, the storm-rain reached the earth to beat upon it and send muddy freshets sweeping down to the plain. The short rivers between the mountains and the sea became torrents loaded with silt. Sometimes their mouths and the direct discharge of the water to the sea were blocked and swamps took the place of well-drained land.

Farming in this country, therefore, depended above all on one great feature of farming, proper drainage. Against heavy rain falling upon precipitous hills, men had to protect the soil if they were to be great farmers of it. The men of the Latium were great farmers and they accomplished astonishing things.

Monsieur la Blanchère, excavator in Latium, revealed in part what the farmers did. He found an extensive engineering system of water-control and drainage, numerous relics of drains, tunnels and dams. 'By diverting the rain waters from the eroding mountain gullies into underground channels', writes Professor Frank, 'the farmers not only checked a large part of the ordinary erosion of the hillside farms, but also saved the space usually sacrificed to the torrent-bed. It would be difficult to find another place where labour had been so lavishly expended to preserve the arable soil from erosion.' Noting the finely trimmed polygonal masonry of the dams, largely made of blocks weighing half a ton each, the professor adds: 'It, is impossible, after surveying such elaborate undertakings, to avoid the conclusion that Latium in the sixth century B.C. was cultivated with an intensity that has seldom been equalled anywhere.'

The men of Latium, later to be known after their capital city as Romans, began their unequalled story with a *tremendous, vital force*, that of an exceptional and well-treasured soil. One can immediately realize the vigorous and profound respect for farmers and farming which characterized the Roman poets, prose writers and statesmen of much later ages, and their looking backward to their ancestors as men of exceptional fibre and character derived from their farming. They looked back to something exceptional in seeking for the origin of the firm strength of Rome.

These great farmers, who protected their land from the torrential invasions of the climate, had also to protect it against the invasions of human beings, not neighbours merely, but those who had come over the Alps and Apennines in search of land. The

farmers then proved themselves great warriors. Farmer and warrior contended within them, but as successes in war grew, so the warrior factor transcended that of the farmer, and the type of farming changed. The number of small farmers, able to keep themselves and their families well on less than five acres of intensive farming, decreased. From the point of view of the soil, indeed, the story of Latium, Rome and its empire, was largely a race between warriors gaining land by conquest and exploitation, and farmers losing it by enforced, inferior ways of farming and by erosion. But amongst the splendour of Rome's achievements, this basic quality of her story has hardly been perceived. The rebelling soil was there all the time, and, in the end, it was the rebellious soil that broke the strength of the warrior.

It is very understandable that, if farmers were liable to be called up for national service as warriors, intensive, personal farming suffered. The farms could not be kept in good condition when many of the men, who worked upon them, were away at the wars.

This drain began with the wars the Romans fought in or about Latium, but it only became critical at the time of the terrific struggle of Rome against Carthage and particularly as the result of the fifteen years of Hannibal's warfare within Italy itself. That led to an immense destruction, not only of the farmer-warriors themselves, but of water-channels, drainage, farm buildings, roads, bridges, trees and other props of intensive farming.

When the war was over, the government of the victorious but exhausted Romans was faced with the question of the reconstruction of the land.

Now at the same time that this question became paramount in Roman Italy, it also became paramount in China. The Chinese Empire of that time was situated in the middle part of the Huang Ho (known to us as the Yellow River) basin and the great territories on either side of it. To protect his empire against the warriors of the Tartars, the famous Chinese Emperor, Chin Chi Huangti, resolved to build a huge, fortified wall. To build it, he had to procure vast numbers of labourers and these he had to take from the land. So he abolished the Tsing Tien system and the inalienability of the land, which was the essential part of it, turned the peasants from their holdings and sold the land to all able and willing to buy. In both the Roman dominion and that of Chin Chi Huangti the land was the chief source of wealth. The rich men, therefore, readily bought the land of the dispossessed peasant families. So, after the second Punic War in Italy and the building of the Great Wall in China, the rulers of Italy and the rulers of China were faced with the same question, a question *the most momentous perhaps of all questions in the final story of mankind upon the earth*: Shall the *common* form of farming be by owners of small holdings or shall it be that of large estates owned by a small class of wealthy men?

The Chinese chose the former method. The great Chin Chi Huangti lived out his day, but immediately after his strong hand had been removed by death, revolt broke out,

his son was slain and the Han Dynasty (202 B.C.-A.D. 220) brought with it the long struggle between the imperial ministers, who aimed at the restoration of the Tsing Tien system of small family holders, and the new aristocracy of large landowners of Chin Chi Huangti. The struggle was long and bitter, but in the end, save for some large estates which the land itself dictated as needful, the Tsing Tien system was restored.

This restored also the Wisdom of the East, for the direct relation of the great majority of Chinese subjects to the creative soil was the ultimate basis of the Wisdom of the East.

In Italy the same struggle occurred. It was also prolonged and bitter, but always, if slowly, success turned away from small family ownership.

In the peace that followed the conflict with Hannibal, the Roman statesmen strove to turn the current back to the traditional ways of their forefathers, but Rome's conquests and the great influx of foreign slaves to work the land in the place of the dispossessed peasants, in addition to the injury to the soil wrought by the war, weighed heavily in favour of the wealthy classes. To all the land was the chief source of wealth. There were, at that time, no large manufacturing towns, and little commerce, for, in the words of Professor Tenny Frank, 'the ancient world has no record of any state of importance so unconcerned about its commerce as was the Roman Republic'. On the other hand, in favour of the small landowners, was the firmly rooted belief that those who worked upon the land were also the finest warriors and the chief strength of Rome's military power.

The great Roman writers were fully aware of this. Cato the Censor (234-149 B.C.) staunchly maintained that it was the farmers and tillers of the soil who made the best citizens and bravest soldiers. Varro (116-27 B.C.) voiced the same conviction that country life in its form of peasant-farming was the chief strength of the State. Cicero eulogized the farmer-citizens, who left the plough to save the State, and used his unequalled art to protect working farmers, whose extinction was threatened by the growth of wealthy proprietors. Virgil used the persuasion of poetry to exalt the culture of the land by the hands which possessed it. Horace, like the greater poet, proclaimed the older type of farming as the best. Columella, at the time of the Emperors Claudius and Nero (A.D. 41-68), declaimed against the poverty of the land, which resulted from handing its cultivation over 'to the unreasoning management of ignorant and unskilful slaves'. Pliny, the Elder, who wrote about the same time as Columella, championed those who worked their own land against the owners of the *latifundia* or great estates, who abandoned the work upon the land to slaves and for their own part only lived in their country houses when they could entertain house parties of their friends. How was it, he asked, there was so great a fertility of the soil in the past that seven *jugera* (a little over four acres) were held to be sufficient for a farmer and his family? His answer was that in those days the lands were tilled by the hands of generals and soldiers. 'Whether', he questioned, 'it was that they tended the seed with

the same care that they had displayed in the conduct of wars and manifested the same diligent attention to their fields that they had done in the arrangement of their camp, or whether it is that under the hand of honest men everything prospers the better by being attended to with scrupulous exactness?' The conception lasted up to the time of Vegetius, in the fourth century, who bitterly regretted the abandonment of the ancestral ways, when he saw the poor quality of the military recruits.

The great Roman writers of the latter part of the Republic and the early part of the Empire, then, had a passion and a hope for the reconstruction of the family ownership of the land not only because the farmers were the healthiest, most honest, and most diligent members of the State, as well as its best farmers, but because in times of danger they made the best soldiers.

The military leaders of the late republic were equally convinced of the value in character and physique of the farming class. When the supply of farmer-warriors failed, there seemed to be only one alternative and that was to start with warriors and, as a reward for their services, to give them land to farm. Marius was the first to give the twist from farmer-warriors to warrior-farmers. He overthrew the tradition that only the propertied classes were worthy to fight for their country, enlisted the proletariat, especially those who were living on the land, and rewarded their services with a gift of land. Slaves were never enlisted. Their grievances were too great and their numbers too many for any Roman to dare or even dream of such a dangerous experiment.

When the change to empire brought its long years of peace, its good government, its roads, its reliable civil servants, its self-governing city states served by an unequalled zeal on the part of public-minded citizens, its greater humanity towards slaves, and such prosperity that, of the best part of these first two centuries (from the death of Domitian in A.D. 96 to the ascension of Commodus in A.D. 180), Gibbon could write, 'If a man were called to fix the period in the history of the world during which the condition of the human race was most happy and prosperous, he could without hesitation name' that between these two dates, even then, the emperors, almost without exception, strove to revive the small family holdings. Augustus and his successors planted colonists on the land; Nerva spent millions in purchasing land for small farmers; generous laws dealt with the food of the agricultural classes; veterans were given free allotments; and Pertinax allowed squatters to occupy uncultivated fields even upon imperial estates, and to possess full ownership if they brought them into cultivation.

Nevertheless, in spite of these desperate endeavours to reconstruct personal farming, the power of money prevailed. The small farming class continuously and literally lost ground and the wealthy class as continuously gained it. In the place of the generous laws of the first two centuries of the empire, there came the restrictive laws of the last two centuries. Agricultural slaves were bound to the land. Heavy impositions and innumerable duties or liturgies were loaded upon the large class of *curiales*, or

members of the senates of the city-states and large villages. This class of *curiales* included the landowners. As the demands of revenue became more exacting, membership of the *curiae* was made hereditary. The *curiales*, harassed by innumerable officials, duties that could not be fulfilled, poverty which withheld money from the land and forced them more and more to exploit their deteriorating soils, sought by every means to escape from their ruinous property and its duties. 'Many of them', wrote Abbott and Johnson in *Municipal Administration in the Roman Empire*, 1926, 'abandoned their property and fled. Others sought to enter some vocation which would give them exemption from municipal charges. The emperors strove to check this movement by binding the *curiales* to their place of origin, and by forbidding them to enter any of the privileged professions.'

These measures failing, laws were then passed under which all the property of the *curiae*, whose members managed to escape, was made liable for the accustomed dues, the burden then falling on the less fortunate owners. Failure in payment led to the confiscation of property and its transference to the imperial estates which rapidly increased in all parts of the empire, and the tenants of which were exempted from municipal liabilities. Some also fell to the owners of the great *latifundia*, who were strong enough to resist the demands of the tax-gatherer or to hand on the burden of taxation to their tenants, who had originally sought their patronage as the only way of escape. The *coloni* or voluntary tenants were also bound to the soil and in the fourth century were reduced almost 'to the level of agricultural slaves'. 'The only class in the municipalities not affected by imperial legislation was the proletariat. The practice of Rome in maintaining this parasitic element by private charity was unfortunately widely copied, and imposed a serious charge on the civic budget. Not only that but the glamour of ancient urban life attracted labour from the farms and other industries where a bare living was gained by arduous toil. In the city one could be fed at the expense of the State, and when the *capitatio plebeia*' (a tax imposed by Diocletian on the working power of a man in good health) 'was removed from the residents of the towns, we cannot wonder that the urban movement went on apace' (Abbott and Johnson).

All this downward career was both accompanied and caused by the continuous depletion of soil-fertility. To this Italy, the imperial mother-country, was the most exposed, and upon her soil the story of its effect was most mournfully unfolded. In the early days of Rome seven *jugera* (4-1/4 acres) were found sufficient for a family, and this was the original assignment given to the *coloni* as tenants of the state. Gracchus found it advisable to increase the assignments to thirty *jugera*. The fall in fertility due to the war against Hannibal forced upon much Italian land the necessity of large ranches devoted to the raising and feeding of domestic animals or to orchards, and this necessity justified economically the brutality of the 'Enclosures' of that time, under which land that had previously grown good crops of grain was taken from evicted small farmers by the wealthy classes and cultivated as ranches. This, in its turn, confirmed the dependence of the masses upon imported corn. Caesar, as an evidence of the soil's further depletion, raised the assignments to sixty *jugera*, and

Columella, writing about A.D. 60, asserted that a fourfold return of grain was unknown on Italian farms. Finally, in the third and fourth centuries the debasement of the soil completed itself. Much of Latium, once the parent of the sturdy strength of the Latin fathers, became a pestilential swamp. Provinces, which had once been the native land of formidable legions, were almost bereft of the human species. Flourishing towns dwindled to villages and disappeared. The proletariat of Rome ceased to exist.

The capitalists of the western capital did not await the complete degradation of Italy. They transferred their capital at the call of Constantine the Great (A.D. 288-337) to a new capital city on the shores of the Bosphorus, a city situated midway between the rich wheat lands that ringed the Black Sea and the inexhaustible fertility brought annually in the Nile flood. Abandoned Italy fell to Odoacer in A.D. 476.

Now this story will be found to be fraught with meaning to those conversant with or, by a perusal of these pages, about to become conversant with the past story of agriculture in England and the present state of agriculture throughout the British Empire and other countries of Western civilization. Amongst other things, they will also see the perilous significance of the attempt of the Nazis to conquer the world and bind subject peoples to slavery upon the land. This subjection of the land, against which so many of the great Romans vainly strove, advanced steadily and irresistibly as an inevitability of a civilization which valued the soil as a commodity producing money, not as the very creator of the life and health of man.

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2020 Vision Brief 44, June 1997

LAND DEGRADATION IN THE DEVELOPING WORLD: Issues and Policy Options for 2020

by Sara J. Scherr and Satya Yadav

By the year 2020 land degradation may pose a serious threat to food production and rural livelihoods, particularly in poor and densely populated areas of the developing world. Appropriate policies are required to encourage land-improving investments and better land management if developing countries are to sustainably meet the food needs of their populations.

Land degradation takes a number of forms, including depletion of soil nutrients, salinization, agrochemical pollution, soil erosion, vegetative degradation as a result of overgrazing, and the cutting of forests for farmland. All of these types of degradation cause a decline in the productive capacity of the land, reducing potential yields. Farmers may need to use more inputs such as fertilizer or manure in order to maintain yields, or they may temporarily or permanently abandon some plots. Degradation may also induce farmers to convert land to lower-value uses. For example, farmers may plant cassava, which demands few nutrients, instead of maize, or convert cropland to grazing land.

Farmland degradation can also have important negative effects off the farm, including deposition of eroded soil in streams or behind dams, contamination of drinking water by agrochemicals, and loss of habitat.

Existing estimates of the current global extent and severity of the problem should be considered indicative at best. The Global Land Assessment of Degradation (GLASOD), based only on the impressions of experts, estimates that nearly 2 billion hectares worldwide (22 percent of all cropland, pasture, forest, and woodland) have been degraded since mid-century. Some 3.5 percent of the 2 billion total is estimated to have been degraded so severely that the degradation is reversible only through costly engineering measures, if at all. Just over 10 percent has been moderately degraded, and this degradation is reversible only through major on-farm investments. Of the nearly 1.5 billion hectares in cropland worldwide, about 38 percent is degraded to some degree. Africa and Latin America appear to have the highest proportion of degraded agricultural land, and Asia has the highest proportion of degraded forestland (Figure 1).

Various sources suggest that 5 to 10 million hectares are being lost annually to severe degradation. If this trend continues, 1.4 to 2.8 percent of total cropland, pasture, and forestland will have been lost by 2020. Declining yields (or increasing input requirements to maintain yields) could be expected over a much larger area. These data are, however, likely to overestimate the problem, as they do not account for the effects of land improvements, which also appear to be widespread.

The Impact on Global Agricultural Production

Globally, there are few studies of the impact of degradation on agricultural production. Pierre Crosson, in a 1994 study, analyzed GLASOD results and other data and concluded that there has been a 17 percent cumulative productivity loss over 45 years (1945–90) as a

result of degradation. During that same period, growth in global food production and long-term declines in grain prices were unprecedented; clearly other factors offset the effects of degradation on aggregate performance.

A 1995 study by Rattan Lal of the impact in Africa based on field data estimated that yield reductions due to past erosion may range from 2 percent to 40 percent, with a mean of 8.2 percent for the continent and 6.2 percent for Sub-Saharan Africa. If accelerated erosion continues unabated, yield reductions by the year 2020 may be 16.5 percent for the continent and 14.5 percent for Sub-Saharan Africa. Evidence from four Southeast Asian and three Middle Eastern countries indicates a degradation-induced decline in productivity greater than 20 percent.

Hot Spots

Declining food supplies from specific regions due to degradation are likely to have only a modest effect on global food supplies, because of the potential for substitution from other producing areas. However, land degradation could have dramatic effects in specific countries and subregions.

Nutrient depletion is predicted by the experts to cause serious problems in the mid-altitude hills of Nepal, in poor soil quality areas of northeastern India and Myanmar now undergoing transition to permanent agriculture, and in areas in northeastern Thailand, where farmers consistently extract more nutrients from the soil than they put in. It is also expected to cause major problems in large areas of Africa under transition to short fallow or permanent cropping, in areas of reduced silt deposits in the Nile delta, in the subhumid Mesoamerican hillsides, and in the semi-arid Andean valleys, northeastern Brazil, and the Caribbean Basin lowlands, where agriculture is undergoing intensification.

Salinization will be a major threat in the irrigation systems of the Indus, Tigris, and Euphrates River basins, in northeastern Thailand and China, in the Nile delta, in northern Mexico, and in the Andean highlands.

Agrochemical pollution is expected to be critical in cotton-producing areas in Turkey, in high-density and coastal areas in East and Southeast Asia, on banana plantations in Central America, in areas of intensive agriculture in Bolivia, and in peri-urban agriculture in Southeast Asia and Mexico City.

Soil erosion will create serious production problems in southeast Nigeria, in Haiti, and on the sloping lands of the Himalayan foothills, southern China, Southeast Asia, and Central America. Major wind erosion problems will develop in West Asia as rangelands are converted to grain production, in the Sahel, in West Africa owing to poor mechanization techniques, in the dry Andean Valley, and in the Brazilian *cerrados*.

Vegetative degradation of rangelands will accelerate by 2020, as a result of overgrazing and overexploitation of vegetation for fuel, in the trans-Himalayas and in Southern and North Africa. The spread of Imperata grassland areas in Southeast Asia will also contribute to degradation.

Agriculture-induced deforestation by 2020 will threaten critical habitats in parts of Southeast Asia, Madagascar, the humid Amazon, the hillsides and Atlantic lowlands of Central America, the Pacific rain forest of Colombia and Ecuador, and the Chaco region of Latin America.

Strategies to Reduce Land Degradation

Historical and socioeconomic evidence suggests that farmers often respond actively to degradation by modifying their farming systems or practices and through land-improving investments. Unfortunately, no global or even national data are yet available estimating the

scale and effects of land improvements (for example, area under terracing or other soil conservation practices), although data collection efforts are beginning.

Although some types of degradation are irreversible, most can be prevented or reversed by, for example, adding nutrients to nutrient-depleted soil, rebuilding topsoil through soil amendments, reestablishing vegetation, or buffering soil acidity. The practicality of rehabilitating degraded landscapes depends on the costs relative to the value of the output or environmental benefits expected.

Despite the lack of quantitative data, it is clear that land-improving investments are creating a number of “bright spots” in the developing world. Agroforestry, community forestry, and afforestation are beginning to have large-scale positive impacts in numerous countries. Conservation farming is spreading widely in countries including Morocco, the Philippines, and Thailand and regionally in East Africa, parts of West Africa, Mesoamerica, and parts of South America. Water management is improving through water-saving irrigation, water harvesting, aquaculture, small-scale irrigation, and salinization control.

Diversification into higher-value perennial crops is protecting soils in Africa, Asia, and Latin America. Dryland range rehabilitation schemes are showing positive results in Syria and Jordan, Southern Africa, Mexico, and northern Argentina. Farmer incentives for land investment are improving through range cooperatives in Jordan; more favorable property rights in Cambodia, Ethiopia, Laos, and Vietnam; and community-based natural resource management in many areas.

Policy Recommendations

An effective response to land degradation calls for improving the incentives for farmers to care for their land and improving their access to the knowledge and inputs required for proper care. Based on lessons learned from past successes and failures in managing land degradation, the following policy actions should be considered:

- Increase research and technology development for land management, and improve the spread of information, through widely linked, user-friendly information systems for farmers.
- Promote land-improving investments (for example, building up soil organic matter, planting trees, and installing small-scale irrigation) through technical assistance and new financing arrangements suitable for low-income farmers.
- Encourage long-term land improvements by securing property rights and rights of access to natural resources, particularly for the poor.
- Develop planning systems for sustainable land use that involve key resource user groups.
- Improve the economic environment for farmers by developing market infrastructure, correcting distorted price incentives, and encouraging rural income growth and diversification.
- For marginal regions, encourage more public investment in infrastructure, social services, and agricultural support services.

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“A 2020 Vision for Food, Agriculture, and the Environment” is an initiative of the International Food Policy Research Institute (IFPRI) to develop a shared vision and a consensus for action on how to meet future world food needs while reducing poverty and protecting the environment. Through the 2020 Vision initiative, IFPRI is bringing together divergent schools of thought on these issues, generating research, and identifying recommendations. The 2020 Briefs present information on various aspects of the issues.

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ACIDIFICATION FROM FERTILIZER USE LINKED TO SOIL AGING

Thirty-seven years of data collected from a plot at the University of Wisconsin-Madison's Arlington agricultural research station is yielding alarming results: acidification from excess fertilizer is wearing out the soil.

Phillip Barak, UW associate professor of soil chemistry and plant nutrition, is part of a team carrying on research that was begun in 1962 by emeritus soil scientist Lloyd Peterson. The Arlington plot has been planted to tobacco and soybeans, as well as 15 years of continuous corn. This history mirrors many Wisconsin fields that have been rotated among a variety of crops.

Barak and his colleagues have found the cation exchange capacity, or the soil's ability to hold onto small bits of calcium, magnesium and potassium, decreases because of soil acidity.

"This change is irreversible," he said.

According to Fred Madison, UW soil science professor, this is important news for farmers.

"Now you've got a whole path of destruction," he said.

Producers may have overlooked the danger that excess nitrogen poses to groundwater, but evidence that it may also permanently damage the soil is beginning to garner attention, Madison said.

Barak said health experts have long known the role that nitrogen plays in blue baby syndrome, a condition in which high levels of nitrogen inhibit the blood's ability to transport oxygen.

Barak said soil becomes more acidic when nitrogen sources, whether from urea,

legume plowdown – such as alfalfa and red clover – or commercial fertilizer are not completely used up by the crop. This excess nitrogen becomes nitric acid, which destroys the soil's vital ability to retain the calcium, magnesium and potassium necessary for crop growth. Instead, these nutrients leach out of the soil and into the groundwater. Although they are harmless, they do cost money to replace – a price that Barak estimates at 20 percent of what farmers normally spend on nitrogen fertilizers.

According to Barak, the United States has a 50 percent applied nitrogen efficiency rate. This means only half of the nitrogen applied by farmers is actually taken up by the plants, leaving the other half to become nitric acid, he said.

"That's like a tanker truck of nitric acid being dumped on a field," Barak said.

These tons of unneutralized nitric acid age the soil very quickly, according to Barak. He said the soil at his Arlington test site has, in 30 years of "normal" agricultural acid inputs, aged the equivalent of 5,000 years with natural source acid inputs.

Barak said the aging is remarkable considering the age of the soils. "Keep in mind these soils have only been in existence for 10,000 years," he said.

Barak said the fine soils of Wisconsin are "tender," and the very qualities that make them fertile also make them vulnerable. They are easily dissolved by acidity, he said.

According to Barak, if excess nitrogen inputs continue, unneutralized, northern soils might soon become like the sandy, less productive soils of the southeast region of the United States.

"With the long term, over-application of nitrogen, we run the risk of irreparably damaging the soil," Madison said.

But Barak said the news is not all bad. He cited two ways farmers can better care for their valuable soil.

The first, and preventative, measure is to use nitrogen more efficiently. Producers should account for all sources of nitrogen, and adjust their commercial inputs accordingly. Excess nitrogen not only acidifies, it can leach into groundwater or run off into surface water.

The second, and remedial, measure is applying agricultural lime. Liming can neutralize the damaging acid and protect the fields. "Agliming has been known for 3,000 years," Barak said. "Use it. It's like TUMS for the soil." By closely monitoring pH levels and appropriately applying agricultural lime, farmers can greatly retard what Barak refers to as "accelerated soil weathering."

Since 1950, Barak reports that nitrogen use, as well as agricultural production, has skyrocketed. The United States is locked into a system of high production that cannot be reversed without serious negative implications, he said. The result is that farmers must learn to be more attentive to their treatment of the soil.

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This story first appeared in the March 3, 1999 issue of the Badger Herald, an independent student newspaper at the University of Wisconsin-Madison.

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FARMING costs Britain more than £2.3 billion each year, according to the most detailed study yet of the industry's wider balance sheet. This bill, which includes the cost of cleaning up pollution, repairing habitats and coping with sickness caused by farming, almost equals the industry's income.

The study puts figures on the external costs of farming-the costs that farmers themselves don't have to pay for. It comes up with a cost of £208 per hectare, which is double the amount suggested by previous, less detailed, studies of the costs in Germany and the US. But the survey's chief author, Jules Pretty of the Centre for Environment and Society at the University of Essex, still describes this figure as "very conservative".

"Agriculture does more than just produce food-it has a profound impact on many other aspects of local, national and global economies and ecosystems, and these impacts can be positive or negative," says Pretty. Farming can erode soils, reduce biodiversity and poison rivers, he says, as well as adding to global warming. Environmental economists say the findings suggest the need for a radical rethink of Europe's farming policy.

The figures in the study have been compiled from many different sources. In 1996, water companies spent £214 million removing pesticides, nitrates and farm pathogens from drinking water. The bill for food poisoning includes an allowance for the victims' lost wages as well as the cost of their hospital treatment.

The annual tab of £25 million for nature conservation is the figure the government agency English Nature has calculated as the cost of restoring endangered species and wildlife habitats damaged by agriculture. The bill of £1.1 billion for air pollution and greenhouse emissions includes, for example, the cost of flood protection as a result of rising sea levels.

"We have been explicitly conservative," says Pretty. He says that lack of reliable data forced him to leave out some costs, such as the health impact on farmers of using pesticides. He has also ignored the damage farmers do to their own land, and more intangible costs such as the value of spoilt landscapes.

"The study has only estimated externalities that give rise to actual financial costs," says Pretty. All the costs have to be paid for sooner or later, either through increased prices or higher taxes. The findings are to be published in the journal *Agricultural Systems* next year.

Pretty sees the figures as a strong argument for redirecting agricultural subsidies, which currently run at £3 billion a year. He says the lion's share of the subsidy should go to farms that do not damage the environment, while dirty farms should lose their subsidy. "Farming had better clean up quickly if it wants that money," he says.

"This is one of the most important areas of agricultural research not dealt with by government," says Jim Dixon, an economist with English Nature's farming unit. "The government looks at farm incomes and subsidies, but not at the external costs of modern farming on the environment or consumers."

Fred Pearce

From **New Scientist** 18 December 1999.

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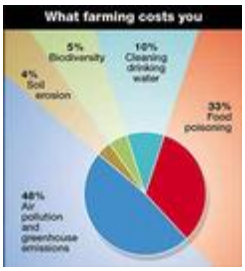

The costs of farming

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Are Large Farms More Efficient?

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Author Info

Willis L. PETERSON ()

Abstract

Accurate estimates of returns to scale require that inputs and output are measured without error and that environmental and managerial differences among firms of varying sizes are taken into account. Measurement problems affecting estimates of returns to scale in agriculture include: (1) combining the farm dwelling with capital inputs, (2) correlation of environmental and management characteristics with size and (3) the effect of off-farm employment on small farm output and production costs. Estimates of long run average total cost curves for farms in the corn belt reveal that after the above factors are taken into account, estimated scale economies in agriculture disappear, while there is evidence of diseconomies as farm size increases.

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POLICY BRIEF № 4

The Multiple Functions and Benefits of Small Farm Agriculture

In the Context of Global Trade Negotiations

By Peter M. Rosset, Ph.D.

September 1999

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Summary

In this *Policy Brief* I challenge the conventional wisdom that small farms are backward and unproductive. Using evidence from Southern and Northern countries I demonstrate that small farms are "multi-functional"Â—more productive, more efficient, and contribute more to economic development than large farms. Small farmers can also make better stewards of natural resources, conserving biodiversity and safe-guarding the future sustainability of agricultural production.

The on-going process of trade liberalizationÂ—now being taken a step further in the World Trade Organization (WTO) negotiations for the Agreement on Agriculture (AoA)Â—has already had dramatically negative effects on small farmers everywhere. The AoA has the potential to severely undercut the remaining viability of small farm production, with potentially devastating consequences for rural economies and environments worldwide. I conclude with a call to recognize the true multi-functional role and value of small farmers, and to unite in opposition to an AoA that might make their continued existence impossible.

Introduction

For more than a century mainstream economists in both capitalist and socialist countries have confidently and enthusiastically predicted the demise of the small, family farm. Small farms have time and again been labeled as backward, unproductive and inefficientÂ—an obstacle to be overcome in the process of economic development. The American model of large scale, mechanized, corporate agriculture is held out as the best, if not the only way to efficiently feed the world's population. Small farmersÂ—or "peasants"Â—have been expected to go the way of the dinosaurs, and rightly so, according to conventional wisdom.

In this *Policy Brief* I challenge the conventional wisdom about small farms and assert that they are "multi-functional"Â—more productive, more efficient, and contribute more to economic development than large farms. I argue that small farmers make better stewards of natural resources, conserving biodiversity and better safe-guarding the sustainability of production. The evidence I present evidence comes from both the Third World and from industrialized countries like the United States.

Today's on-going process of liberalization in international agricultural tradeÂ—now being taken a step further in the Millennium Round of World Trade Organization (WTO) negotiationsÂ—is widely recognized to have dramatically negative effects on small farmers in both Northern and Southern countries. This puts the small farm issueÂ—called *The Agrarian Question* by renowned social scientist Karl Kautsky at the beginning of this century-Â—squarely on the agenda for debate at the end of the millennium.

If small farms are worth preservingÂ—if indeed a small farm model of rural development makes more sense than does the large-scale, mechanized, chemical intensive, corporate dominated and socially excluding model toward which business-as-usual is carrying usÂ—then now is the time to act.

The first point worth noting is that while small farmers have been driven out of rural America by the millions, and we have seen a similar, though lessor rural-urban migration in the Third World, the fact is that family farmers do still persist in the U.S. and continue to be numerically dominant. In the Third World they are central to the production of staple foods. The prediction of their demise continues to be premature, though their numbers have dropped substantially and they face new threats to their livelihoods on an unprecedented scale.

The second point is that small farms are far from being as unproductive or inefficient as so many would have us believe. Peasants have stubbornly clung to the land despite more than a century of harsh policies which have undercut their economic viability.

The third point is that small farms have multiple functions which benefit both society and the biosphere, and which contribute far more than just a particular commodityÂ—though there is ample evidence that a small farm model for agricultural development could produce far more food than a large farm pattern ever could. These multiple and beneficial functions should be seriously valued and considered before we blithely accept yet another round of anti-small farm policy measuresÂ—this time at the level of the global economy. It is toward the second and third pointsÂ—the benefits of small farms, that I direct the bulk of this paper.

In the conclusion to this *Policy Brief* I outline the grave threat to small farms presented by the WTO negotiations for an Agreement on Agriculture (AoA). Several countries, led by the United States, seek to push further free trade in agricultural products. I show how this could lead to the destruction of small farms and severely damage rural environments worldwide.

I close by issuing a call to rally around the concept of the multiple functionality of small farms, for both human societies and for the biosphere. By recognizing the important role played by small farms we have an opportunity to stop and even reverse trade policies which erode the viability of small farms.

Small Farm Virtues in the U.S.

I am not alone in speaking to the value of small farms and calling for policy change to take advantage of their potential dynamism. The United States Department of Agriculture's (USDA) National Commission on Small Farms released a landmark report in 1998 titled *A Time to Act.* What the USDA calls the *public value of small farms* includes:

. **Diversity**: Small farms embody a diversity of ownership, of

cropping systems, of landscapes, of biological organization, culture and traditions. A varied farm structure contributes to biodiversity, a diverse and esthetically pleasing rural landscape, and open space.

b. **Environmental benefits:** Responsible management of the natural resources of soil, water, and wildlife on the 60 percent of all U.S. farms less than 180 acres in size, produces significant environmental benefits for society. Investment in the viability of these operations will yield dividends in the stewardship of the nation's natural resources.

c. **Empowerment and community responsibility**: Decentralized land ownership produces more equitable economic opportunity for people in rural areas, as well as greater social capital. This can provide a greater sense of personal responsibility and feeling of control over one's life, characteristics that are not as readily available to factory line workers. Land owners who rely on local businesses and services for their needs are more likely to have a stake in the well-being of the community and the well-being of its citizens. In turn, local land owners are more likely to be held accountable for any negative actions that harm the community.

d. **Places for families**: Family farms can be nurturing places for children to grow up and acquire values. The skills of farming are passed from one generation to another under family ownership structures. When farm children do not continue to farm, farming knowledge, skills and experience are lost.

e. **Personal connection to food**: Most consumers have little connection to agriculture and food production. As a consequence, they have little connection with nature, and lack an appreciation for farming as cultivation of the earth for the production of food that sustains us. Through farmers' markets, community supported agriculture, and the direct marketing strategies of small farmers, consumers are beginning to connect with the people growing their food, and with food itself as a product of a farmer's cooperation with nature.

f. **Economic foundations**: In various states and regions of the U.S., small farms are vital to the economy.

The USDA Commission on Small Farms concludes with a powerful call to change the policies that have favored large, corporate-style farms for so very long, with hideous costs to rural communities and the environment.

Small Farm Virtues in the Third World

A similar pattern holds in the Third World, where policies promoting large farm, export agriculture have increasingly eroded the viability of small farms, despite the many benefits small scale production of food offers.

In traditional farming communities the family farm is central to

maintaining community and to the sustainability of agricultural production. On the small farm, productive activities, labor mobilization, consumption patterns, ecological knowledge and common interests in long-term maintenance of the farm as a resource, contribute to a stable and lasting economic and family-based enterprise. Work quality, management, knowledge and relationships are intertwined and mutually reinforcing. Short-term gain at the risk of degrading essential resources not only invites community sanction, but also places the family and the farm at risk of collapse. Family farmers regularly achieve higher and more dependable production from their land than do larger farms operating in similar environments. Labor intensive practices such as manuring, limited tillage, ridging, terracing, composting organic matter, and recycling plant products into the productive process, enhance soil conservation and fertility (Netting, 1993).

The durability of small farm production is clear in its historical and spatial ubiquity: small farms exist in all environments, in all political and economic contexts, in all historical periods over the last 5,000 years, and in every known cultural area where crops can be grown. Small farmers have developed and use a variety of technologies, crops, and farming systems. Perhaps most important in an era of diminishing non-renewable resources, small farmers frequently produce with minimal recourse to expensive external inputs (Netting, 1993).

We must value the multiple functions of farms in the Third World if we are to achieve a sustainable agriculture, according to the Food and Agriculture Organization (FAO) of the United Nations (1999):

> To face the current challenges of agriculture, we need to address agriculture and land in a broader context by integrating multiple roles (economic, food production, nature and land management, employment etc.). Sustainable agriculture and land use is not just a means to obtain more food and income, in socially acceptable ways which do not degrade the environment. Rather, it has an all-encompassing impact on communities, environments, and consumers. We must reach a consensus and common understanding of sustainable land use as an opportunity to improve the quality of the environment, including its physical (increased soil fertility, better quality air and water), biological (healthier and more diverse animal, plant, and human populations), and social, economic and institutional (greater social equity, cohesion, peace/stability, well-being) components... Land is not just a resource to be exploited, but a crucial vehicle for the achievement of improved socioeconomic, biological and physical environments. Concretely, by paying attention to the multiple functions of agriculture and land use, all economic, social and environmental functions of agriculture, at multiple levels, are recognized and included in decision making in order to promote synergies between these functions and to

reconcile different stakeholder objectives.

Small farms play multiple key functions in rural economies, cultures and ecosystems worldwide. In the following sections I summarize some of the evidence for these claims.

Small Farm Productivity

How many times have we heard that large farms are more *productive* than small farms? Or that they are more *efficient?* And that we need to consolidate land holdings to take advantage of that greater productivity and efficiency? The actual data shows exactly the reverse for productivity: that smaller farms produce far more per unit area than larger farms. Part of the problem lies in the confusing language used to compare the performance of different farm sizes. As long as we use crop *yield* as *the* measure of productivity, we will be giving an unfair advantage to larger farms.

Total Output versus Yield

If we are to fairly evaluate the relative productivity of small and large farms, we must discard "yield" as our measurement tool. Yield means the production per unit area of a single crop, like "metric tons of corn per hectare." One can often obtain the highest yield of a single crop by planting it alone on a field -- in a monoculture. But while a monoculture may allow for a high yield of one crop, it produces nothing else of use to the farmer. The bare ground between the crop rows -- empty "niche space" in ecological terms -- invites weed infestation. The presence of weeds makes the farmer invest labor in weeding or capital in herbicide.

Large farmers tend to plant monocultures because they are the simplest to manage with heavy machinery. Small farmers on the other hand, especially in the Third World, are much more likely to plant crop mixtures -- intercropping -- where the empty niche space that would otherwise produce weeds instead is occupied by other crops. They also tend to combine or rotate crops and livestock, with manure serving to replenish soil fertility.

Such integrated farming systems produce far more per unit area than do monocultures. Though the yield per unit area of one cropÂ—corn, for exampleÂ—may be lower on a small farm than on a large monoculture, the total output per unit area, often composed of more than a dozen crops and various animal products, can be far, far higher. Therefore, if we are to compare small and large farms we should use *total output,* rather than yield. Total output is the sum of everything a small farmer produces: various grains, fruits, vegetables, fodder, animal products, etc. While yield almost always biases the results toward larger farms, total output allows us to see the true productivity advantage of small farms.

Surveying the data we indeed find that small farms almost always produce far more agricultural output per unit area than larger farms. This holds true whether we are talking about an industrial country like the United States, or any country in the Third World. This is now widely recognized by agricultural economists across the political spectrum, as the "inverse

relationship between farm size and output" (Barret, 1993; Ellis, 1993; Tomich et al., 1995; Berry and Cline, 1979; Feder, 1985; Prosterman and Riedinger, 1987; Cornia, 1985; to name a few). Even leading development economists at the World Bank have come around to this view, to the point that they now accept that re-distribution of land to small farmers would lead to greater overall productivity (Deininger, 1999; Binswanger et al., 1995), a view long since arrived at by others (see Sobhan, 1993; Lappé et al., 1998). Table 1 shows the relationship between farm size and ouput per acre in the United States. The smallest farms, those of 27 acres or less, have more than ten times greater dollar output per acre than larger farms. While this is in large part due to the fact that smaller farms tend to specialize in high value crops like vegetables and flowers, it also reflects relatively more labor and inputs applied per unit area, and the use of more diverse farming systems (Strange, 1988).

Table 1: Farm Size versus Output in the United States, 1992

Median Farm Size Category (Acres)	*Average Gross Output ($/Acre)*	*Average Net Output ($/Acre)*
4	7424	1400
27	1050	139
58	552	82
82	396	60
116	322	53
158	299	55
198	269	53
238	274	56
359	270	54
694	249	51
1364	191	39
6709	63	12

Source: U.S. Agricultural Census, vol. 1, part 51, pp. 89-96, 1992.

Figure 1 graphically shows the relationship between farm size and total output for fifteen countries in the Third World. In all cases relatively smaller farm sizes are much more productive per unit areaÂ—2 to 10 time more productiveÂ—than are larger ones. We observe two general forms of the relationship, as shown in Figure 2. Curve **I** is found in countries where the smallest reported farm size category is the most productive per unit area. Curve **II** is found where the most productive size category, while not *the* smallest, is still *relatively* small. All countries for which data is available fit one of these two types. The data presented in Table 1, from the U.S., clearly matches type I.

There are a variety of explanations for the greater productivity of small

farms in the Third World (Netting, 1993; Lappé et al., 1998). Some of these are:

. multiple cropping: as explained above, while large farmers almost always use monocultures, and one or at the most two cropping cycles per year, small farmers are more likely to intercrop various crops on the same field, plant multiple times during the year, and integrate crops, livestock and even aquaculture, making much more intensive use of space and time.

b. land use intensity: larger farmers and land owners tend to leave much of their land idle, while small farmers tend to use their entire parcel.

c. output composition: large farms are oriented toward land extensive enter-prises, like cattle grazing or extensive grain monocultures, while small farmers emphasize labor and resource intensive use of land. As in the U.S. case, large farms may produce crops with lower value than do smaller farms.

d. irrigation: small farmers may make more efficient use of irrigation.

e. labor quality: while small farms generally use family labor -- which is personally committed to the success of the farm -- large farms use relatively alienated hired labor.

f. labor intensity: small farms apply far more labor per unit area than do larger farms.

g. input use: small farms often use far more inputs per unit area than larger farms, though the mix on small farms favors non-purchased inputs like manure and compost while large farms tend to use relatively more purchased inputs like agrochemicals.

h. resource use: large farms are generally less committed to management of other resources -- such as forests and aquatic resources -- which combine with the land to produce a greater quantity and better quality of production.

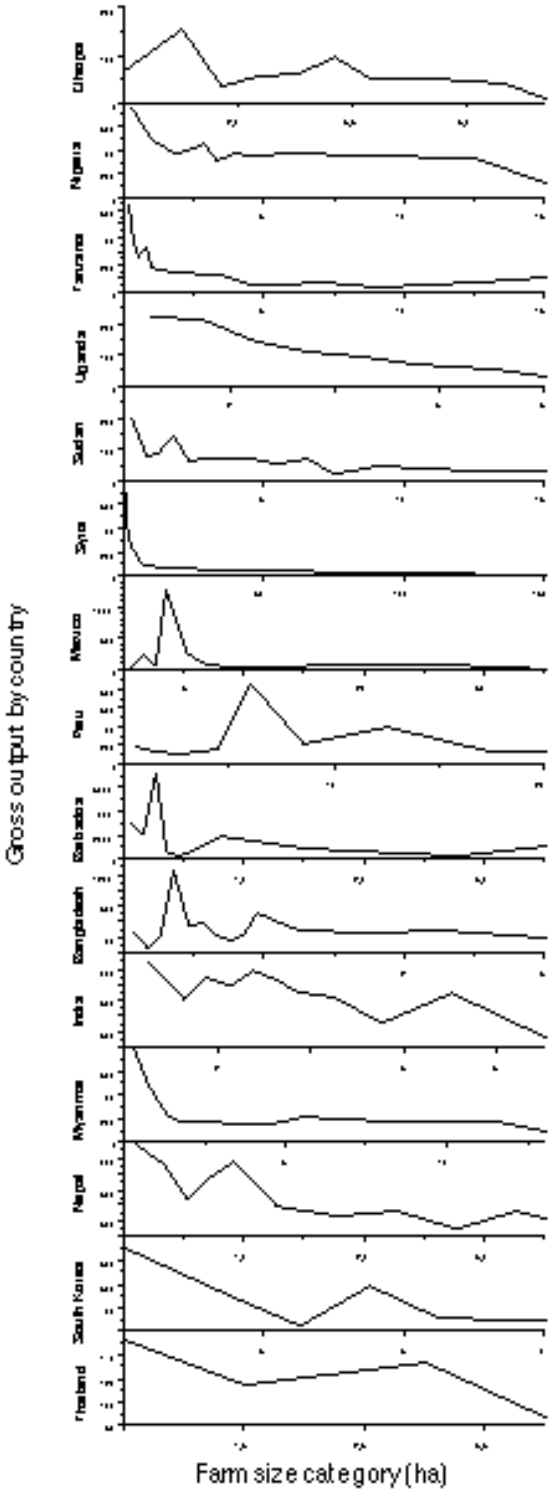

Figure 1. The relationship between farm size and total output in different countries (after Cornia, 1985).

It is the commitment that family members have to their farm, and the complexity and integrated nature of small farms, that guarantee their advantage in terms of output. Pretty (1997) has documented the productivity of such systems in a wide variety of environments.

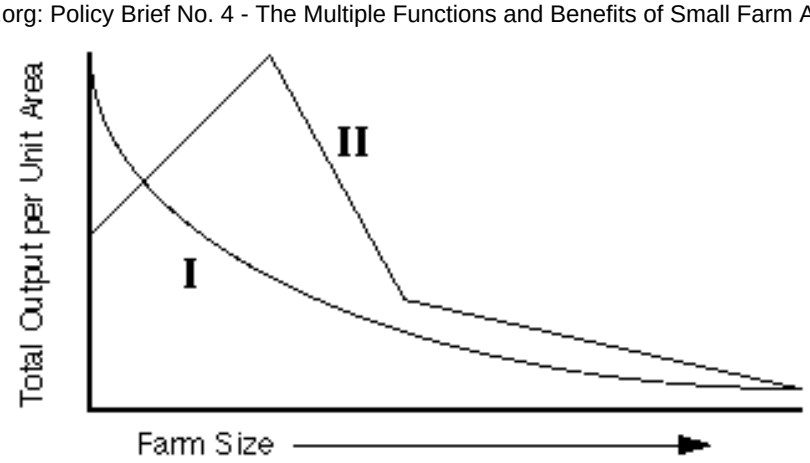

Figure 2. Typical forms of the relationship between farm size and total output.

In Type I the smallest farm sizes produce the most total output per unit area. In Type II the most productive size class is not the smallest, but is still relatively small. These idealized types have been abstracted from the data presented graphically in Figure 1.

Small Farm Efficiency

While small farms are clearly more productive than large farms in terms of output per unit area, claims are often made that large farms are still *more efficient*. To start with, this depends on the definition of efficiency that one chooses. Small farms make more efficient use of land. Large farms generally have higher labor productivity due to mechanization, so they might be considered to be more efficient in labor usage. The definition of efficiency most widely accepted by economists is that of "total factor productivity," a sort of averaging of the efficiency of use of all the different factors that go into production, including land, labor, inputs, capital, etc. Tomich et al. (1993, p. 126) provide data from the 1960s, 70s and early 80s, which show small farms have greater total factor productivity than large farms in Sub-Saharan Africa, Asia, Mexico and Columbia. The curves follow the same patterns, Types I or II, shown in Figure 2 for farm size vs. output. More recently, the same pattern has been found in Honduras (Gilligan, 1998).

In industrial countries like the U.S. the pattern is less clear. The consensus position is probably that very small farms are inefficient because they can't make full use of expensive equipment, while very large farms are also inefficient because of management and labor problems inherent in large operations. Thus peak efficiency is likely achieved on mid-sized farms that have one or two hired laborers, giving the U.S. an efficiency curve like the Type II productivity curve, but with the peak more toward mid-size than small (Strange, 1988, pp. 80-81; see also Madden, 1967). In a recent, detailed analysis of true total factor productivity, corrected for a number of biases in the data, the author concludes that advantages to larger farm sizes found by some analysts "disappear, while there is evidence of diseconomies as farm size increases" (Peterson, 1997). In other words, even in the United States, there is no reason to believe that large farms are

more efficient, and very large farms may in fact be quite *inefficient*. But there is far more to the economic importance of small farms once we move outside the farm gate and ask questions about economic development.

Small Farms in Economic Development

Surely more bushels of grain is not the only goal of farm production; farm resources must also generate wealth for the overall improvement of rural lifeÂ—including better housing, education, health services, transportation, local business diversification, and more recreational and cultural opportunities.

Here in the United States, the question was asked more than a half-century ago: what does the growth of large-scale, industrial agriculture mean for rural towns and communities? Walter Goldschmidt's classic 1940's study of California's San Joaquin Valley compared areas dominated by large corporate farms with those still characterized by smaller, family farms (see Goldschmidt, 1978).

In farming communities dominated by large corporate farms, nearby towns died off. Mechanization meant that fewer local people were employed, and absentee ownership meant that farm families themselves were no longer to be found. In these corporate-farm towns, the income earned in agriculture was drained off into larger cities to support distant enterprises, while in towns surrounded by family farms, the income circulated among local business establishments, generating jobs and community prosperity. Where family farms predominated, there were more local businesses, paved streets and sidewalks, schools, parks, churches, clubs, and newspapers, better services, higher employment, and more civic participation. Studies conducted since Goldschmidt's original work confirm that his findings remain true today (see Fujimoto, 1977; MacCannell, 1988; Durrenberger and Thu, 1996).

The Amish and Mennonite farm communities found in the eastern United States provide a strong contrast to the virtual devastation described by Goldschmidt in corporate farm communities. Lancaster County in Pennsylvania, which is dominated by these small farmers who eschew much modern technology and often even bank credit, is the most productive farm county east of the Mississippi River. It has annual gross sales of agricultural products of $700 million, and receives an additional $250 million from tourists who appreciate the beauty of traditional small farm landscapes (D'Souza and Ikerd, 1996). Ludwig and Anderson (1992) argue that Amish farm communities provide a North American model for what they call "indigenous development," essentially an emphasis on building a strong local economy as the basis for participating in the larger world:

> The *vision* of indigenous development is one of global *inter*-dependence through the *intra*-dependence of semiautonomous regions. Instead of placing emphasis on the highest or global level of competitive interaction, it starts at

> the bottom and places emphasis on the development of strong, independent, semiautonomous regions with unique identitiesÂ… Many of the Amish communities, separated by self-defined boundaries, areÂ… self-reliant. These [are] interesting examples because their economies are market oriented and highly successful; they do substantial trade with the outside; they are great husbands of the natural environment; and their members find a great deal of meaning and centeredness in their work. While their economies are market based, they are highly diverse and integrated rather than fragmented, cooperative rather than competitive, based on value added rather than on commodity products, and dedicated to reciprocity more than dominance (p.35).

If we turn toward the Third World we find similar local benefits to be derived from a small farm economy. The Landless Workers Movement (MST) is a grassroots organization in Brazil that helps landless laborers to organize occupations of idle land belonging to wealthy landlords (Langevin and Rosset, 1999). When the movement began in the mid-1980s, the mostly conservative mayors of rural towns were violently opposed to MST land occupations in surrounding areas. In recent times, however, their attitude has changed. Most of their towns are very depressed economically, and occupations can give local economies a much needed boost. Typical occupations consist of 1,000 to 3,000 families, who turn idle land into productive farms. They sell their produce in the marketplaces of the local towns and buy their supplies from local merchants. Not surprisingly those towns with nearby MST settlements are now better off economically than other similar towns, and many mayors now actually petition the MST to carry out occupations near their towns (Candido Gryzbowski, IBASE, personal communication).

It is clear that local and regional economic development benefits from a small farm economy, as do the life and prosperity of rural towns. Can we re-create a small farm economy in places where it has been lost, to improve the wellbeing of the poor?

Improving Social Welfare Through Land Reform

Recent history shows that the re-distribution of land to landless and land-poor rural families can be a very effective way to improve rural welfare. Sobhan (1993) examined the outcome of virtually every land reform program carried out in the Third World since World War II. He is careful to distinguish between what he calls 'radical' re-distribution (called 'genuine land reform' by Lappé et al., 1998), and 'non-egalitarian' reforms (or 'fake land reform' in the Lappé et al.'s terminology). When quality land was really distributed to the poor, and the power of the rural oligarchy to distort and 'capture' policies broken, real, measurable poverty reduction and improvement in human welfare has invariably been the result. Japan, South Korean, Taiwan and China are all good examples. In contrast, countries with reforms that gave only poor quality land to beneficiaries, and/or failed to alter the rural power structures that work against the poor, have failed to

make a major dent in rural poverty. Mexico and the Philippines are typical cases of the latter (Sobhan, 1993; Lappé et al., 1998).

While Sobhan looked at national-level statistics to derive his conclusions, Besley and Burgess (1998) recently looked at the history of land reform in 16 individual Indian states from 1958 to 1992. While these were by and large not radical reforms in Sobhan's sense, many did abolish tenancy and reduce the importance of intermediaries. The authors found a strong relationship between land reform and the reduction of poverty. Similarly in Brazil, land reform beneficiaries and members of MST-settlements have a higher standard of living than those families who remain landless (Candido Gryzbowski, IBASE, personal communication). In fact land reform holds promise as a means to stem the rural-urban migration that is causing Third World cities to grow beyond the capacity of urban economies to provide enough jobs.

In Brazil IBASE, a social and economic research center, studied the impact on government coffers of legalizing MST-style land occupations-*cum*-settlements versus the services used by equal numbers of people migrating to urban areas. When the landless poor occupy land and force the government to legalize their holdings, it implies costs: compensation of the former landowner, legal expenses, credit for the new farmers, etc. Nevertheless the total cost to the state to maintain the same number of people in an urban shanty town -- including the services and infrastructure they use -- exceeds in just one month, the yearly cost of legalizing land occupations (Candido Gryzbowski, IBASE, personal communication).

Another way of looking at it is in terms of the cost of creating a new job. Estimates of the cost of creating a job in the commercial sector of Brazil range from 2 to 20 times more than the cost of establishing an unemployed head of household on farm land, through agrarian reform. Land reform beneficiaries in Brazil have an annual income equivalent to 3.7 minimum wages, while still landless laborers average only 0.7 of the minimum. Infant mortality among families of beneficiaries has dropped to only half of the national average (Stédile, 1998).

This provides a powerful argument that land reform to create a small farm economy is not only good for local economic development, but is also more effective social policy than allowing business-as-usual to keep driving the poor out of rural areas and into burgeoning cities.

Sobhan (1993) argues that *only* land reform holds the potential to address chronic underemployment in most Third World countries. Because small farms use more labor -- and often less capital -- to farm a given unit of area, a small farm model can absorb far more people into gainful activity and reverse the stream of out-migration from rural areas. What of national economic development? How do countries characterized by small farms fare compared to those dominated by large farms?

National Economic Development and 'Bubble-Up' Economics

In turns out that a relatively equitable, small farmer-based rural economy does provide the basis for strong national economic development. This "farmer road to development" is part of the reason why, early on in its history, the United States developed more rapidly and evenly than Latin America, with its inequitable land distribution characterized by huge haciendas and plantations interspersed with poverty-stricken subsistence farmers (de Janvry, 1981). In the United States, independent "yeoman" farmers formed a vibrant domestic market for manufactured products from urban areas, including farm implements, clothing and other necessities. This domestic demand fueled economic growth in the urban areas, and the combination gave rise to broad-based growth (Sachs, 1987).

More recently the post-war experiences of Japan, South Korea and Taiwan demonstrate how equitable land distribution fuels economic development. At the end of the war circumstances, including devastation and foreign occupation, conspired to create the conditions for 'radical' land reforms in each country, breaking the economic stranglehold of the landholding class over rural economic. Combined with trade protection to keep farm prices high, and targeted investment in rural areas, small farmers rapidly achieved a high level of purchasing power, which guaranteed domestic markets for fledging industries (Sachs, 1987).

The post-war economic 'miracles' of these three countries were each fueled at the start by these internal markets centered in rural areas, long before the much heralded 'export orientation' policies which much later on pushed those industries to compete in the global economy. This was real triumph for 'bubble-up' economics, in which re-distribution of productive assets to the poorest strata of society created the economic basis for rapid development. It stands in stark contrast to the failure of 'trickle down' economics to achieve much of anything in the same time period in areas of U.S. dominance, such as much of Latin America (Sachs, 1987).

A further benefit of small farm development through land reform in East Asia was the dispersal of political power. Economically enfranchised small farmers became an important political base that politicians had to respond to, avoiding the kind of urban biases in policy-making that have sabotaged economic development in much of the Third World (Sachs, 1987).

More generally, there is now a growing consensus among mainstream development economists, long called for by those on the left, that inequality in asset distribution impedes economic growth (Solimano, 1999). This is leading even such institutions as the World Bank to call for land reform, albeit of a 'non-radical,' 'market-led' variety I do not necessarily endorse (see for example, Banerjee, 1998; Stiglitz, 1998; Deininger and Binswanger, 1998; for the alternative view, see complaints in Inspection Panel, 1999).

Ecosystem Services & Sustainability

The benefits of small farms extend beyond the economic sphere. Whereas large, industrial-style farms impose a scorched-earth mentality on resource

management -- no trees, no wildlife, endless monocultures -- small farmers can be very effective stewards of natural resources and the soil. To begin with, small farmers utilize a broad array of resources and have a vested interest in their sustainability. At the same time, their farming systems are diverse, incorporating and preserving significant functional biodiversity within the farm. By preserving biodiversity, open space and trees, and by reducing land degradation, small farms provide valuable ecosystem services to the larger society.

In the United States, small farmers devote 17% of their area to woodlands, compared to only 5% on large farms. Small farms maintain nearly twice as much of their land in "soil improving uses," including cover crops and green manures (D'Souza and Ikerd, 1996). In the Third World, peasant farmers show a tremendous ability to prevent and even reverse land degradation, including soil erosion (Templeton and Scherr, 1999).

Many small farm agroecosystems in the Third World are are located on a wide variety of slopes, aspects, microclimates, elevational zones, and soil types. They are surrounded by many different vegetation associations. There are numerous combinations of diverse biophysical factors which have led to the diverse cropping patterns developed by farmers to exploit site-specific characteristics. Descriptions of the species and structural diversity and management of these traditional systems are found throughout the literature on agroecology (see for example, Altieri, 1995; Pretty, 1995; Netting, 1993; *The Ecologist*, 1998).

In many areas traditional farmers have developed and/or inherited complex farming systems which are highly adapted to local conditions, allowing them to sustainably manage production in harsh environments while meeting their subsistence needs, without depending on mechanization, chemical fertilizers, pesticides or other technologies of modern agricultural science (Altieri 1995).

Compared to the ecological wasteland of a modern export plantation, the small farm landscape contains a myriad of biodiversity. The forested areas from which wild foods, and leaf litter are extracted, the wood lot, the farm itself with intercropping, agroforestry, and large and small livestock, the fish pond, the backyard garden, allow for the preservation of hundreds if not thousands of wild and cultivated species. Simultaneously, the commitment of family members to maintaining soil fertility on the family farm means an active interest in long-term sustainability not found on large farms owned by absentee investors.

If we are truly concerned about rural ecosystems, then the preservation and promotion of small, family farm agriculture is a crucial step we must take.

Conclusions:

Free Trade Threatens Small Farm Agriculture

Throughout this paper I have examined the multiple functions played by small farms, and the myriad benefits they provide for society and for the

biosphere. If we are concerned about food production, small farms are more productive. If our concern is efficiency, they are more efficient. If our concern is poverty, land reform to create a small farm economy offers a clear solution. The small farm model is also the surest route to broad-based economic development. If the loss of biodiversity or the sustainability of agriculture concern us, small farms offer a crucial part of the solution.

Despite decades of anti-small farm policies taken by nation states (Lappé et al., 1998), small farmers have clung to the soil in amazing numbers. But today we stand at a cross-roads. As a world we are poised to take steps toward global economic integration that pose far greater threats to small farmers than they have ever faced before.

Trade liberalizationÂ—the move toward global free trade policiesÂ—poses a grave threat to the continued existence of small farms throughout the world. Over the past couple of decades Third World countries have been encouraged, cajoled, threatened, and generally pressured into unilaterally reducing the level of protection offered to their domestic food producers in the face of well-financed foreign competitors. Through participation in GATT, NAFTA, the World Bank, the International Monetary Fund and the World Trade Organization, they have reduced or some cases eliminated tariffs, quotas and other barriers to unlimited imports of food products (Bello et al., 1999). On the face of it, this might sound like a good thing. After all, more food imports might make food cheaper in poor, hungry countries, and thus make it easier for the poor to obtain enough to eat. However, the experiences of many countries suggest that there are downsides to these policies which may outweigh the potential benefits.

Typically Third World economies have been inundated with cheap food coming from the major grain exporting countries. For a variety of reasons (subsidies, both hidden and open, industrialized production, etc.) this food is more often than not put on the international market at prices below the local cost of production. That drives down the prices that local farmers receive for what they produce, with two related effects, both of which are negative (Lappé et al., 1998).

First, a sudden drop in farm prices can drive already poor, indebted farmers off the land over the short term. Second, a more subtle effect kicks in. As crop prices stay low over the medium term, profits per unit areaÂ—per acre or hectareÂ—stay low as well. That means the minimum number of hectares needed to support a family rises, contributing to abandonment of farm land by smaller, poorer farmersÂ—land which then winds up in the hands of the larger, better off farmers who can compete in a low price environment by virtue of having very many hectares. They overcome the low profit per hectare trap precisely by owning vast areas which add up to good profits in total, even if they represent very little on a per hectare basis. The end result of both mechanisms is the further concentration of farm land in the ever fewer hands of the largest farmers (Lappé et al., 1998).

A penalty is paid for this land concentration in terms of productivity, as

large farmers turn to monocultures and machines to farm such vast tracts, and in terms of the environment, as these large mechanized monocultures come to depend on agrochemicals. Jobs are lost as machines replace human labor and draft animals. Rural communities die out as farmers and farm workers migrate to cities. Natural resources deteriorate as nobody is left who cares about them. Finally, food security is placed in jeopardy: domestic food production falls in the face of cheap imports; land that was once used to grow food is placed into production of export crops for distant markets; people now depend on moneyÂ—rather than landÂ—to feed themselves; and fluctuations in employment, wages and world food prices can drive millions into hunger.

This process should be a more or less familiar one to North Americans, who have seen low crop prices and the "get big or get out" mentality of government policy drive four million farmers off the land since World War II (Lappé et al., 1998; Heffernan, 1999). We have paid, and continued to pay, a heavy price of runaway soil erosion from excessive mechanization and "fence row to fence row" planting, of urban problems because our inner cities never did absorb the excess labor expelled from rural America, and of the collapse of rural life.

The major drive to export grain from America's heartland, which began in the 1970s, contributed to a 40 percent increase in soil erosion in the corn and soybean belts. Today about 90 percent of U.S. crop land is losing topsoil faster than it can be replaced (Lappé et al., 1998.) The export boom also contributed to a 25 percent increase in average farm size, which was accompanied by the loss of one third of all American farmers between 1970 and 1992 (U.S. Census of Agriculture, 1992). In Figure 3 we see that the average American farmer has not benefited from the export boom at all. Rather, the profits have accrued to the giant grain cartels (Krebs, 1991).

In a very real sense, then, the U.S. drive to dominate global grain markets has hurt family farmers and damaged rural ecosystems both at home and abroad.

What is euphemistically known as a "fair and market-oriented agricultural trading system"Â—almost totally free trade in farm productsÂ—is unfortunately the agenda of American government negotiators in the Millennium Round of trade negotiations under the World Trade Organization, beginning in the fall of 1999 in Seattle (Permanent Mission of the United States, 1999).

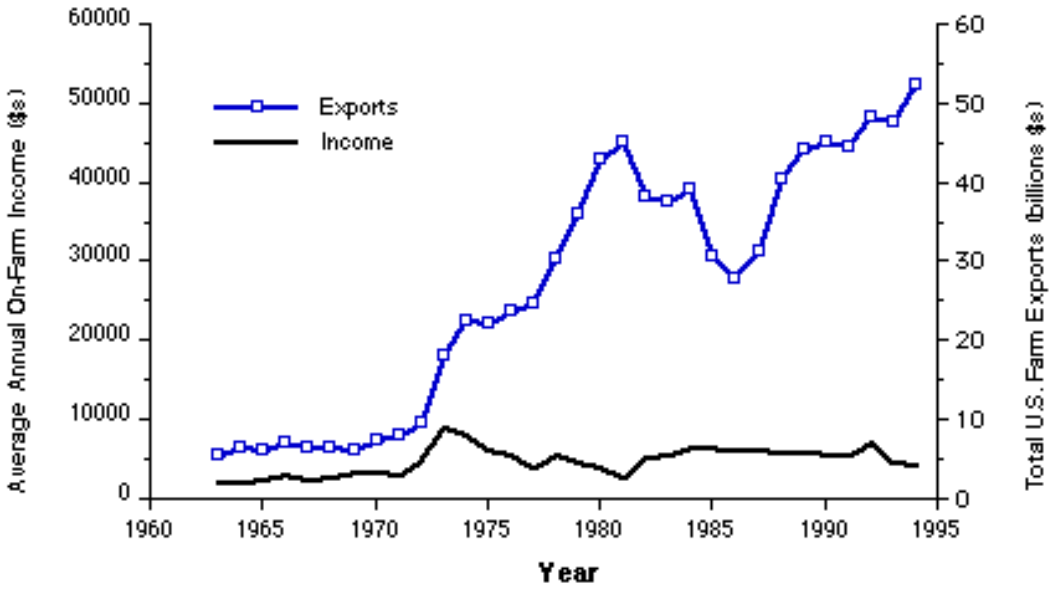

Figure 3. On-Farm Income of the Average U.S. Farmer vs. Total U.S. Farm Exports, 1963-1994.

Sources: Farmer income--Economic Research Service, U.S. Department of Agriculture, Current and Historic Operator Household Income Tables. Exports--Food and Agriculture Organization, FAOSTAT Agriculture Data.

This represents the single gravest threat faced today by the world's rural peoples and ecologies. The further "liberalization" of trade in agricultural products would mean greater freedom for the big to drive out the small, for forcing people everywhere to depend on distant global marketsÂ—with unpredictable price swingsÂ—for the daily meals, another mass exodus from rural areas and the further growth of cities, and could lead to the final triumph of inefficient and ecologically destructive monocultures over ecologically rational and sustainable farming practices.

There is less than unanimous support among the world's nations for the U.S position. A number of countries have taken up the call made in Chapter 14 of Agenda 21, the declaration drawn up at the 1992 Earth Summit in Rio, that "agricultural policy review, planning and integrated programming [be carried out] in the light of the multifunctional aspects of agriculture, particularly with regard to food security and sustainable development."

According to this viewpoint, agriculture produces not only commodities, but also livelihoods, cultures, ecological services, etc., and as such, the products of farming cannot be treated in the same way as other goods. While a shoe, for example, is a relatively simple good whose world price can be set by supply and demand, and the trade in which can be regulated through tariffs or de-regulated by removing them, not so for farming, whose roles are far more complex.

The Japanese government, in a preparatory document for the Seattle negotiations, put it this way (Permanent Mission of Japan, 1999):

> Agriculture not only produces/supplies agricultural products, but also contributes to food security, by reducing the risks

> caused by unexpected events or a possible food shortage in the future, to the preservation of land and environment, to the creation of a good landscape and to the maintenance of the local community, through production activities in harmony with the natural environment. All of these roles are known as the "multifunctionality" of agriculture.
>
> The multifunctionality of agriculture has the following characteristics: (a) Most aspects of multifunctionality are regarded as economic externalities and it is difficult to reflect their values properly in market prices. Though it is closely related to production, it cannot be subject to trade; (b) Market mechanisms alone cannot lead to the realization of an agricultural production method that will embody the multifunctionality of agriculture.

Norway has also endorsed the concept of multifunctionality as the basis for special treatment of farming for reasons of environmental protection, food security and the viability of rural areas (Norwegian Ministry of Agriculture, 1998), as has the European Union to some extent (European Commission, 1999), and as have some other countries.

As an expert in small farm production, I completely endorse this view. Ignoring the multiple functions of agriculture has caused untold suffering and ecological destruction in the past. The time is long overdue to recognize the full range of contributions that agricultureÂ—and small farms in particularÂ—make to human societies and to the biosphere. Farms are not factories that churn out sneakers or tennis racquets, and we cannot let narrow arguments of simple economic expediency destroy this legacy of all human kind.

I call on the world's civil society to demand that our governments respect the multi-functionality of agriculture and grant each country true sovereignty over food and farming, by stepping back from free trade in agricultural products. Instead of deepening policies that damage small farms, we should implement policies to develop small farm economies. These might include genuine land reforms, tariff protection for staple foodsÂ—so that farmers receive fair prices, and the reversal of biases in policies for credit, technology, research , education, subsidies, taxes and infrastructure which unfairly advance large farms at the expense of smaller ones. By doing so we will strike at the root causes of poverty, hunger, underdevelopment and degradation of rural ecosystems.

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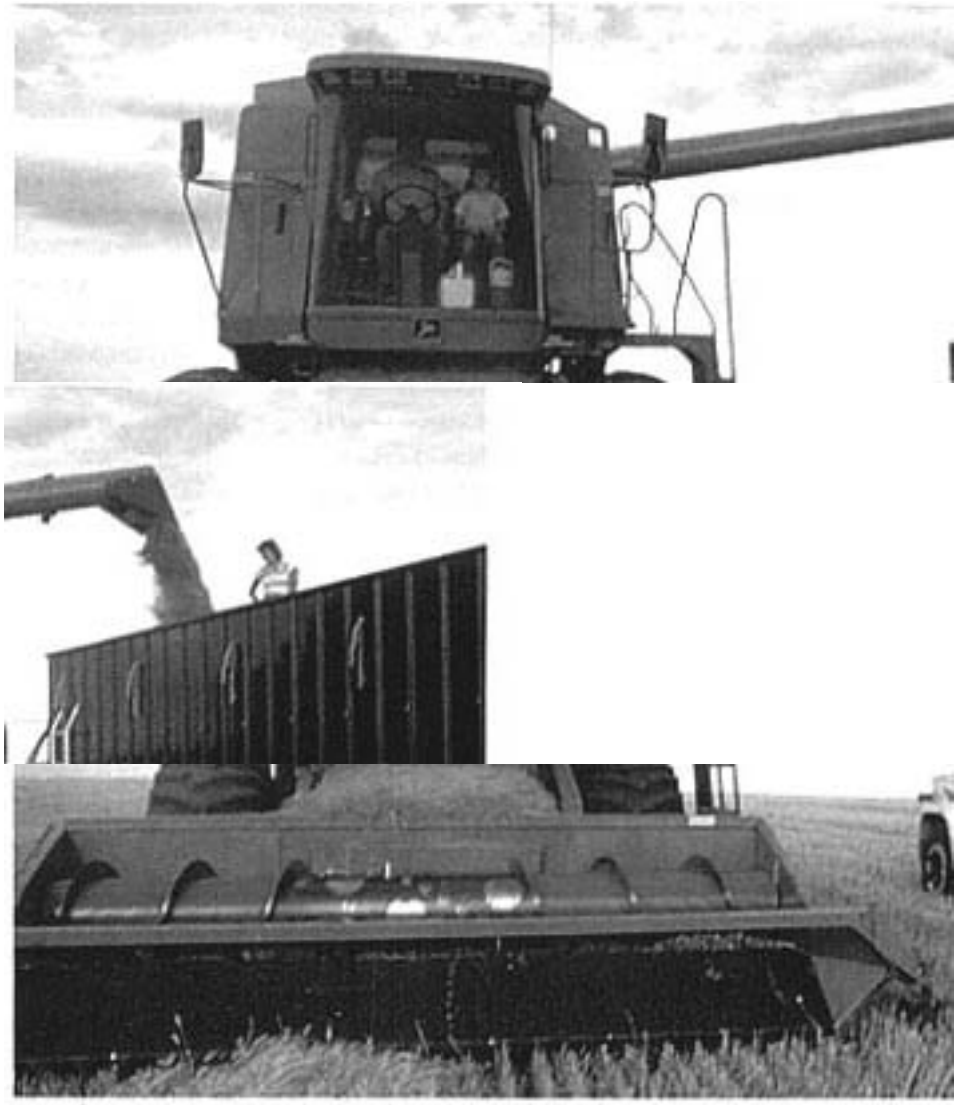

Large farms impose a "scorched earth" policy on the land.

On the Benefits of Small Farms

By Peter Rosset
Executive Director,
Food First

The following article is a condensed version of Food First Policy Brief number 4, The Multiple Functions and Benefits of Small Farm Agriculture in the Context of Global Trade Negotiations. The complete policy brief contains extensive bibliographic references, and can be ordered from the Institute or read at www.foodfirst.org/pubs/policybs/pb4.html

For more than a century, pundits have confidently predicted the demise of the small farm, labeling it as backward, unproductive, and inefficient -- an obstacle to be overcome in the pursuit of economic development. But this is wrong. Far from being stuck in the past, small-farm agriculture provides a productive, efficient, and ecological vision for the future.

If small farms are worth preserving, then now is the time to educate the world's policy-makers about the genuine value of small farm agriculture.

Small Farm Productivity

How many times have we heard that large farms are more *productive* than small farms, and that we need to consolidate land holdings to take advantage of that greater productivity and efficiency? The actual data shows the opposite -- small farms produce far more per acre or hectare than large farms.

One reason for the low levels of production on large farms is that they tend to be *monocultures*. The highest yield of a single crop is often obtained by planting it alone on a field. But while that may produce a lot of one crop, it generates nothing else of use to the farmer. In fact, the bare ground between crop rows invites weed infestation. The weeds then invest labor in weeding or money in herbicide.

Large farmers tend to plant monocultures because they are the simplest to manage with heavy machinery. Small farmers, especially in the Third World, are much more likely to plant crop mixtures -- intercropping -- where the empty space between the rows is occupied by other crops. They usually combine or rotate crops and livestock, with manure serving to replenish soil fertility.

Such integrated farming systems produce far more per unit area than do monocultures.

Though the yield per unit area of one crop -- corn, for example -- may be lower on a small farm than on a large monoculture farm, the total production per unit area, often composed of more than a dozen crops and various animal products, can be far higher.

This holds true whether we are talking about an industrial country like the United States, or any country in the Third World. Figure 1 shows the relationship between farm size and total production for fifteen countries in the Third World. In all cases, relatively smaller farm sizes are much more productive per unit area -- 200 to 1,000 percent more productive -- than are larger ones. In the United States the smallest farms, those of 27 acres or less, have more than ten times greater dollar output per acre than larger farms. While in the U.S. this is largely because smaller farms tend to specialize in high value crops like vegetables and flowers, it also reflects relatively more attention devoted to the farm, and more diverse farming systems.

Small Farms in Economic Development

More bushels of grain is not the only goal of most farm production; farm resources must also generate wealth for the overall improvement of rural life -- including better housing, education, health services, transportation, local business diversification, and more recreational and cultural opportunities.

Here in the United States, the question was asked more than a half-century ago: what does the growth of large-scale, industrial agriculture mean for rural towns and communities? Walter Goldschmidt's classic 1940s study of California's San Joaquin Valley, *As You Sow: Three Studies in the Social Consequences of Agribusiness*, compared areas dominated by large corporate farms with those still characterized by smaller, family farms.

In farming communities dominated by large corporate farms, nearby towns died off. Mechanization meant fewer local people were employed, and absentee ownership meant farm families themselves were no longer to be found. In these corporate-farm towns, the income earned in agriculture was drained off into larger cities to support distant enterprises, while in towns surrounded by family farms, the income circulated among local business establishments, generating jobs and community prosperity. Where family farms predominated, there were more local businesses, paved streets and sidewalks, schools, parks, churches, clubs, and newspapers, better services, higher employment, and more civic participation. Recent studies confirm that Goldschmidt's findings remain true.

If we turn toward the Third World we find similar local benefits to be derived from a small farm economy. The Landless Workers Movement (MST) is a grassroots organization in Brazil that helps landless laborers to organize occupations of idle land belonging to wealthy landlords. When the movement began in the mid-1980s, the mostly conservative mayors of rural towns were violently opposed to MST land occupations in surrounding areas. In recent times, their attitude has changed. Most of their towns are very depressed economically, and occupations can give local economies a much needed boost. Typical occupations consist of 1,000 to 3,000 families, who turn idle land into productive farms. They sell their produce in the marketplaces of the local towns and buy their supplies from local merchants.

Not surprisingly those towns with nearby MST settlements are better off economically than other similar towns, and many mayors now actually petition the MST to carry out

occupations near their towns. Local and regional economic development benefits from a small farm economy, as do the life and prosperity of rural towns. Can we re-create a small farm economy in places where it has been lost, to improve the well-being of the poor?

Recreating a Small Farm Economy

Recent history shows that the re-distribution of land to landless and land-poor rural families can be a very effective way to improve rural well-being. We can examine the outcome of every land reform program carried out in the Third World since World War II, being careful to distinguish between genuine land reforms -— when quality land was really distributed to the poor and the power of the rural oligarchy to distort and "capture" policies was broken -- and "fake land reforms" -- when the poor have been relegated to the poorest, most remote soils. In every case of genuine land reform, real, measurable poverty reduction and improvement in human welfare has invariably been the result.

Japan, South Korea, Taiwan, Cuba, and China are all good examples. In contrast, countries with reforms that gave only poor quality land to beneficiaries, and/or failed to alter the rural power structures that work against the poor, failed to make a major dent in rural poverty. Mexico and the Philippines are typical cases of the latter.

More recently IBASE, a research center in Brazil, studied the impact on government coffers of legalizing MST-style land occupations *cum* settlements versus the services used by equal numbers of people migrating to urban areas. When the landless poor occupy land and force the government to legalize their holdings, it implies costs: compensation of the former landowner, legal expenses, credit for the new farmers, and others. Nevertheless the total cost to the state to maintain the same number of people in an urban shanty town -- including the services and infrastructure they use -- exceeds in just one month, the yearly cost of legalizing land occupations.

Another way of looking at it is in terms of the cost of creating a new job. Estimates of the cost of creating a job in the commercial sector of Brazil range from two to twenty times more than the cost of establishing an unem-ployed head of household on farm land, through agrarian reform. Land reform beneficiaries in Brazil have an annual income equivalent to 3.7 minimum wages, while still landless laborers average only 0.7 of the minimum. Infant mortality among families of beneficiaries has dropped to only half of the national average.

This provides a powerful argument that using land reform to create a small farm economy is not only good for local economic development, but is also more effective social policy than allowing business-as-usual to keep driving the poor out of rural areas and into burgeoning cities.

National Economic Development and "Bubble-Up" Economics

A relatively equitable, small farmer-based rural economy provides the basis for strong national economic development. The post-war experiences of Japan, South Korea, and Taiwan demonstrate how equitable land distribution fuels economic development. At the end of the war, circumstances including devastation and foreign occupation, conspired to create the conditions for "radical" land reforms in each country, breaking the eco-nomic stranglehold of the landholding class over rural economies. Combined with trade protection

to keep farm prices high, and targeted investment in rural areas, small farmers rapidly achieved a high level of purchasing power, which guaranteed domestic markets for fledging industries.

The post-war economic "miracles" of these three countries were each fueled at the start by these internal markets centered in rural areas, long before the much heralded "export orientation" policies which much later on pushed those industries to compete in the global economy. This was real triumph for "bubble-up" economics, in which re-distribution of productive assets to the poorest strata of society created the economic basis for rapid development. It stands in stark contrast to the failure of "trickle down" economics to achieve much of anything in the same time period in areas of U.S. dominance, such as much of Latin America, and to the Asian financial crisis, which happened after many of the original policies had been discontinued.

Good Stewards of Natural Resources

The benefits of small farms extend into the ecological sphere. Where large, industrial-style farms impose a scorched-earth mentality on resource management -- no trees, no wildlife, endless monocultures -- small farmers can be very effective stewards of natural resources and the soil. To begin with, small farmers utilize a broad array of resources and have a vested interest in their sustainability. Their farming systems are diverse, incorporating and preserving significant functional biodiversity within the farm. By preserving biodiversity, open space, and trees, and by reducing land degradation, small farms provide valuable ecosystem services to the larger society.

In the United States, small farmers devote 17 percent of their area to woodlands, compared to only five percent on large farms, and keep nearly twice as much of their land in "soil improving uses," including cover crops and green manures. In the Third World, peasant farmers show a tremendous ability to prevent and even reverse land degradation, including soil erosion.

Compared to the ecological wasteland of a modern export plantation, the small farm landscape contains a myriad array of biodiversity. The forested areas from which wild foods and leaf litter are extracted, the wood lot, the farm itself with intercropping, agroforestry, and large and small livestock, the fish pond, the backyard garden, allow for the preservation of hundreds if not thousands of wild and cultivated species. Simultaneously, the commitment of family members to maintaining soil fertility on the family farm means an active interest in long-term sustainability not found on large farms owned by absentee investors.

The Small Farm Path

To the productive, economic, and environmental benefits of small farm agriculture, we can add the continuance of cultural traditions and of the rural way of life. If we are truly concerned about rural peoples and ecosystems, then the preservation and promotion of small, family farm agriculture is a crucial step we must take.

Institute for Food and Development Policy Backgrounder

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Legume-based cropping systems have reduced carbon and nitrogen losses

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Rodale Institute, 611 Siegfriedale Road, Kutztown, Pennsylvania 19530, USA

In agricultural systems, optimization of carbon and nitrogen cycling through soil organic matter can improve soil fertility and yields while reducing negative environmental impact. A basic tenet that has guided the management of soil organic matter for decades has been that equilibrium levels of carbon and nitrogen are controlled by their net input and that qualitative differences in these inputs are relatively unimportant[1–3]. This contrasts with natural ecosystems in which there are significant effects of species composition and litter quality on carbon and nitrogen cycling[4,5]. Here we report the net balances of carbon and nitrogen from a 15-year study in which three distinct maize/soybean agroecosystems are compared. Quantitative differences in net primary productivity and nitrogen balance across agroecosystems do not account for the observed changes in soil carbon and nitrogen. We suggest that the use of low carbon-to-nitrogen organic residues to maintain soil fertility, combined with greater temporal diversity in cropping sequences, significantly increases the retention of soil carbon and nitrogen, which has important implications for regional and global carbon and nitrogen budgets, sustained production, and environmental quality.

We studied carbon and nitrogen balances in two legume-based and one conventional, fertilizer-driven agroecosystem. The conventional system consisted of a maize/soybean rotation; a mineral nitrogen fertilizer was applied before maize was planted and pesticides were used as needed. The other two cropping systems depended on legumes for nitrogen fixation and were managed on the basis of 'organic' (US) or 'ecological' (Europe) strategies, avoiding the use of synthetic fertilizers and pesticides[6]. One system simulated a beef operation in which crop biomass (legumes and grasses) was fed to beef cattle and the manure was subsequently returned to the field as the primary nitrogen source for maize (MNR system). The other system received nitrogen directly from legumes through incorporation of leguminous biomass before maize planting (LEG system). Maize and soybeans were not present as frequently in these systems as in the conventional system, because small grains and several other legumes were also included in the rotation. Ten-year averages for 1986–95 maize yields were 7,140, 7,100 and 7,170 kg ha^{-1} in the MNR, LEG and conventional systems, respectively, and were not significantly different (analysis of variance ANOVA, $P > 0.5$). For the past ten years of the experiment, economic profitability from the three systems has been comparable[7].

As a result of these distinct management strategies, there were significant quantitative and qualitative differences in organic residue inputs and in soil carbon sequestration. The conventional system had greater mean cumulative above-ground net primary productivity (ANPP, Table 1) and returned more crop residues to the soil than did both of the legume-based systems. The MNR system had the greatest harvest intensity; only 36% ANPP was returned to the soil as crop residues. Total carbon returned to the soil in the MNR and conventional systems, however, was not significantly different, because of steer manure additions in the MNR system (Table 1). The quantity of carbon inputs was not the major factor affecting soil carbon storage in these cropping systems. Even though the MNR and conventional systems received equal amounts of carbon, only the MNR system showed a significant increase in carbon stored in soil (Table 1). The LEG system, with lower average carbon inputs from above-ground sources, also showed an increase in soil carbon.

In contrast to the conventional system, which received only senescent-crop residues (Table 1), the two legume-based systems received relatively diverse residues that differed in terms of biochemical composition (the residues were from senescent crops, leguminous biomass and/or steer manure). Studies of litter-quality effects using agricultural residues have produced inconsistent results[1–3,8,9]. It is likely that the increased carbon storage in the MNR system is partially due to the return of steer manure to the field. Compared with senescent-crop residues, a larger proportion of manure-derived carbon is retained in soil, probably because manure is already partly decomposed and contains a larger proportion of chemically recalcitrant organic compounds[8,9]. On the other hand these studies did not find significant effects of types of plant species on long-term carbon equilibrium[1,8,9].

We studied the potential role of plant-species differences on soil carbon storage, using variations in the natural abundance of $\delta^{13}C$ associated with photosynthetic pathways to estimate the relative contribution of C_4 and C_3 plants to soil organic matter (SOM). Maize, the only C_4 crop present, accounted for 74%, 48% and 22% of the returned residues in the conventional, LEG and MNR systems, respectively. In the conventional system, maize-derived carbon still replaces the original soil carbon deposited by the C_3 temperate forests that preceded agriculture in this region. In this case, net soil carbon levels did not change because the loss of C_3-derived carbon was nearly equivalent to the gain of C_4-derived carbon (Fig. 1). In contrast, the net gains in soil carbon seen in the LEG and MNR systems were due to significant increases in C_3-derived carbon. Levels of soil carbon derived from C_4 plants did not change in the MNR and LEG systems. In the LEG system levels of C_3-derived carbon were disproportionately high, accounting for 88% of the net increase in soil carbon although only half of the

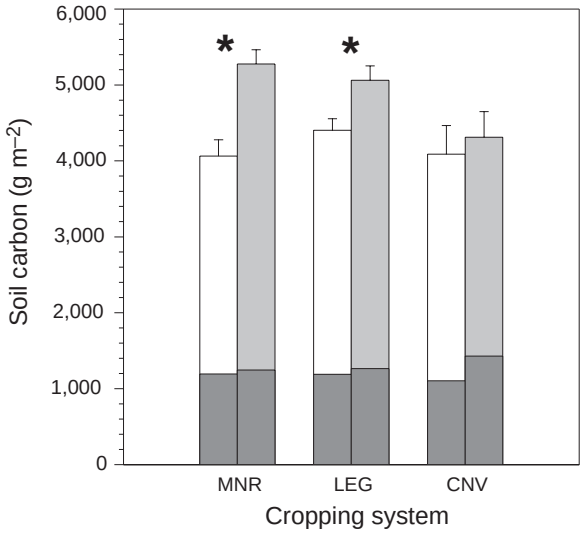

Figure 1 Soil carbon levels in 1981 (left-hand bars) and 1995 (right-hand bars); means ± s.e.m. are shown. MNR, manure as N source; LEG, N directly from legumes; CNV, conventional system (see text). The amount of C_4-derived carbon is indicated by the dark grey portion of each bar; the remainder of each bar represents C_3-derived carbon. Asterisks indicate significant differences in 1995 mean soil carbon levels compared with 1981 levels, ANOVA, $P < 0.05$. In addition to residues from maize, the MNR system also receives unknown amounts of C_4-derived carbon inputs from the steer manure, making a quantitative comparison of the proportion of C_4 inputs and C_4-derived soil carbon impossible in this system.

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Table 1 Plant productivity and changes in soil carbon 1981–95

Cropping system	Net primary productivity*	Plant residues returned†			Manure input†	Total organic residue input†	Change in soil carbon 1981 to 1995‡
		Senescent	Living	Total			
MNR	69a	21	3.7	25a	19	44b	12
LEG	68a	31	7.5	39b	0	39a	6.6
Conventional	75b	43	0	43c	0	43b	2.2§

*Cumulative carbon fixed by annual above-ground net primary productivity; †Carbon in residues returned to the soil; and ‡net changes (increases) in soil carbon; all over 15 years. Senescent residues are from crops and weeds. Residues incorporated from living plants were mainly of leguminous origin in the LEG system but were predominantly from grasses in the MNR system. Numbers within a column followed by a different letter are significantly different at the 0.05 probability level (protected Scheffe's). §There was no significant change in soil carbon in the conventional system (ANOVA, $P > 0.05$). Values are kg carbon $\times 10^{-3}$ per ha.

residues returned were from C_3 plants. Replacement of C_4-derived soil carbon in pools with turnover times of less than 20 years, which accounts for about 5% of the total soil carbon[10], cannot explain this discrepancy. These changes in the natural abundance of $\delta^{13}C$ in SOM in the LEG system indicate that differences in plant-species composition have contributed to differential retention of soil carbon. Plant species can affect carbon equilibrium through differences in below-ground net primary productivity (NPP)[11], the timing and level of root turnover/exudates[12], litter quality[4], tendencies to foster the formation of soil aggregates[13], and changes in microbial community structure and function[14,15].

Qualitative differences in nitrogen inputs also had a major influence on nitrogen retention in these agroecosystems. Nitrogen losses due to leaching in 1991–95 were comparable in the LEG and MNR systems, averaging 13 kg nitrogen $ha^{-1}\,yr^{-1}$, but were about 50% higher in the conventional system, averaging 20 kg $ha^{-1}\,yr^{-1}$, (ANOVA, $P = 0.06$; Fig. 2). Seasonal effects in all cropping systems were similar, with the greatest losses occurring during the late-fall to early-spring months when mineralization tends to exceed crop demand. Leaching losses were greatest from late fall of 1991 to spring of 1993 compared with the later half of the rotation cycle, particularly in the conventional system.

Cumulative nitrogen additions were similar in the conventional and MNR systems, as were nitrogen exports from non-leguminous crops (Fig. 3a, b). Over the course of 15 years, nitrogen inputs from soil amendments have exceeded exports by crops by a total of 520 kg ha^{-1} in the conventional and 540 kg ha^{-1} in the MNR systems (Fig. 3c). Despite these similarities in net balance, there were significant differences in soil nitrogen storage. Most of the surplus nitrogen received by the MNR system over the 15 years can be accounted for by the significant increase in soil nitrogen from 1981 to 1995 (Fig. 3d), whereas in the conventional system soil nitrogen levels have decreased since 1981 (Fig. 3d).

Nitrogen inputs into the LEG system are more difficult to quantify because nitrogen fixed by the green manure was the major nitrogen input. However, we have estimated the maximum nitrogen input from the green manure over 15 years to be 840 kg nitrogen ha^{-1}. If the proportion of nitrogen fixed ranged from 75% to 100%, nitrogen inputs from the green manure would have been 630–840 kg ha^{-1} (Fig. 3a). Non-leguminous exports were not significantly different from those in the conventional system, but were somewhat lower than those in the MNR system (protected Scheffe's, $P < 0.05$; Fig. 3b). Soil nitrogen levels in this system have not changed significantly (Fig. 3d).

The nitrogen unaccounted for in our balance calculations was +240, ±100 and +1,020 kg ha^{-1} in the MNR, LEG and conventional systems, respectively, and probably reflects differences in gaseous losses and nitrogen fixation by soybeans not included in our calculations. Although we have no measurements of gaseous losses, we can estimate the potential impacts of soybeans on nitrogen balance on the basis of data from the experiment. Nitrogen balances suggest that nitrogen fixation was probably lower in conventional-system soybeans and greater in LEG-system soybeans. Calculations for possible nitrogen-fixation scenarios in the LEG and conventional systems show that even large differences in soybean nitrogen-fixation rates between systems did not alter the basic trends in nitrogen balance. For example, if nitrogen fixed by soybeans were 75% of total soybean nitrogen in the LEG system, the net nitrogen input from senescent roots and shoots would have been only 60–140 kg ha^{-1} over 15 years. Likewise, nitrogen extrac-

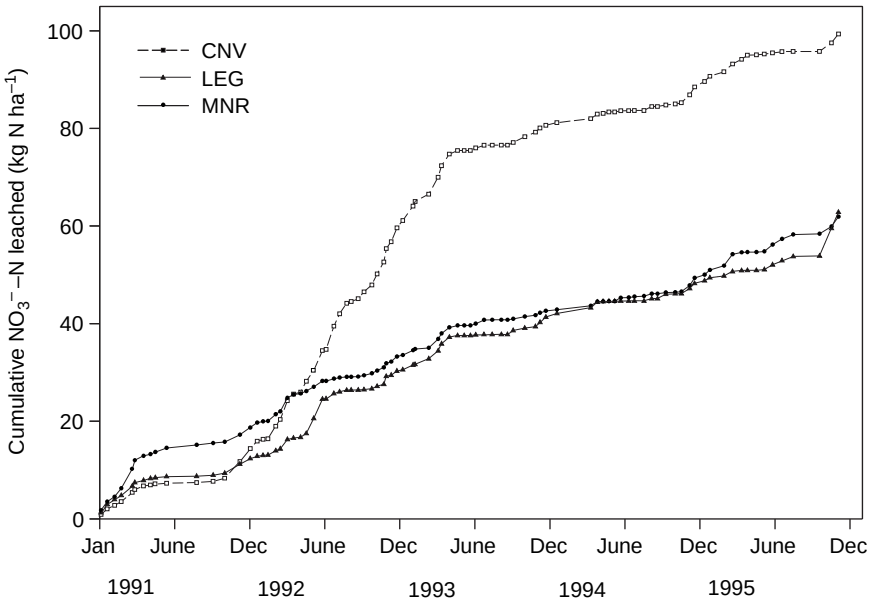

Figure 2 Cumulative nitrate leaching during 1991 to 1995. Means of data from lysimeters installed in three entry points of four replicates are shown. Cumulative nitrogen leached over five years was significantly different across cropping systems (ANOVA, $P = 0.06$).

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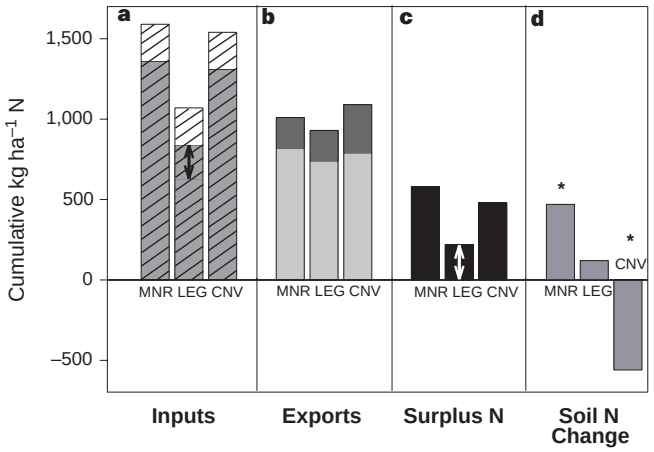

Figure 3 Comparison of cumulative nitrogen inputs and exports and changes in soil nitrogen storage after 15 years. **a**, Nitrogen inputs under the control of the manager (grey with stripes represents nitrogen input from steer manure, leguminous biomass or mineral fertilizers) and estimated environmental nitrogen inputs (white with stripes represents atmospheric nitrogen deposition and nitrogen fixation by free-living bacteria). **b**, Exports of nitrogen from non-leguminous crops (light grey) combined with nitrate leaching losses (dark grey). **c**, Nitrogen surplus based on inputs minus exports. **d**, The change in soil nitrogen is the difference between nitrogen contents in the plough layer for 1995 compared to 1981; asterisks indicate statistical significance, ANOVA, $P < 0.05$. Arrows in LEG-system bars indicate the possible range of nitrogen-fixation inputs.

tion by soybeans in the conventional system can account for only part of the missing 1,020 kg of nitrogen (surplus + change in soil nitrogen); that is, a nitrogen-fixation rate of 40% of soybean total nitrogen would result in the extraction of 280–350 kg ha^{-1} over 15 years, a fairly typical outcome for highly determinant soybeans in maize rotations[16].

These results for nitrogen parallel our findings for carbon, indicating that quantitative differences in nitrogen balance were not the major factor affecting soil nitrogen retention. Instead, qualitative differences in the form of nitrogen inputs and subsequent effects on internal nitrogen cycling had a significant impact on long-term soil nitrogen retention. Detailed microplot studies using ^{15}N as a tracer showed that there are differences in the partitioning of nitrogen from organic versus mineral sources, with more legume–derived nitrogen than fertilizer-derived nitrogen immobilized in microbial biomass and SOM[17,18]. If immobilization is lower in the conventional system compared with in the other two systems, this may explain the greater leaching of NO_3^- that we observed in this system. Differences in plant-species composition may contribute to reducing NO_3^- leaching by scavenging soil nitrogen during periods in which summer cash crops, such as maize and soybeans, are not active[19].

Our results show that even in these intensively managed agro-ecosystems, plant-species composition and litter quality influence SOM turnover markedly. Increases in SOM in the MNR and LEG systems were highly significant in terms of ecosystem function and soil quality. Greater retention of both carbon and nitrogen suggests that use of low carbon-to-nitrogen residues to maintain soil fertility combined with increased temporal diversity restores the biological linkage between carbon and nitrogen cycling in these systems and could lead to improved global carbon and nitrogen balances. Application of these practices in the major maize/soybean growing region in the USA would increase soil carbon sequestration by $0.13–0.30 \times 10^{14}$ g yr^{-1}. This is equal to 1–2% of the estimated annual carbon released into the atmosphere from fossil fuel combustion in the USA[20] (1.4×10^{15} g carbon yr^{-1}, 1994) and is a significant contribution considering that the USA has agreed to reduce average CO_2 emissions to 7% below 1990 levels by 2008–2012 as part of the Kyoto Protocol. In addition, CO_2 emissions from the two legume-based systems are lower than emissions from the conventional system because of a 50% reduction in energy use[21]. The potential effects on the nitrogen cycle are much greater in magnitude because the fixed nitrogen used in agricultural activities is responsible for a 60% increase in global levels of biologically active nitrogen[22]. Reduced nitrogen losses combined with increased soil nitrogen storage will lead to reductions in the amount of nitrogen that must be applied to maintain yields. □

Methods

The experiment covered 6 ha and consisted of a randomized, complete block design. Details of experimental design and farming practices are described elsewhere[23]. Carbon contents of organic residues are calculated from plant biomass data collected from 1981–1995 assuming a carbon content of 42% on a dry weight basis.

Soil analyses. Composite soil samples collected in 1981 and 1995 were analysed for total carbon and nitrogen with the Leco CN-2000 analyser (Leco Corporation). Natural abundance of ^{13}C was determined by combustion of triplicate samples with a Europa Scientific carbon–nitrogen analyser connected to a Europa Scientific Tracermass mass spectrometer. To estimate the original ^{13}C natural abundance before the introduction of C_4 plants, we collected a composite soil sample along two transects from a forested, never-farmed site located ~0.5 km from the experiment. The proportion of carbon derived from corn residues, C_4%, was calculated for 1981 and 1995 as $C_4\% = (\delta_m - \delta_f)/(\delta_{mr} - \delta_f) \times 100$, where $\delta_m = \delta^{13}C$ content of soil after maize cultivation; $\delta_r = -25.58‰$ the $\Delta^{13}C$ content of soil under the nearby native mixed hardwood forest; and $\delta_{mr} = -13.1‰$ the $\delta^{13}C$ content of maize residues[24].

Nitrogen budget. Nitrogen inputs from leguminous green manures were calculated by using above-ground biomass nitrogen content data and adjusting for below-ground contributions using root biomass data and nitrogen content from the experiment in 1997. Values for total nitrogen fixation in these plants were taken from published studies to estimate the minimum proportion of nitrogen fixed[16,25]. Soybeans, which were present in all three cropping systems, were not included in nitrogen-budget calculations because of the potential for variability in nitrogen fixation by soybeans[16]. However, we used our data on soybean yields, residue returns and nitrogen contents to estimate potential impacts on nitrogen balance. Usually, no more than 50% of total soybean nitrogen is derived from nitrogen fixation and generally two-thirds of the total nitrogen is exported from the beans[3,16]. Nitrogen fixation by free-living bacteria, which represents a minor contribution to nitrogen inputs in agricultural systems using tillage, was assumed to be 5 kg nitrogen ha^{-1} yr^{-1} (ref. 26). In earlier work we did not find significant differences in the potential for nitrogen fixation by free-living organisms in these cropping systems[27]. We estimated nitrogen inputs from atmospheric deposition to be 15 kg nitrogen ha^{-1} yr^{-1} on the basis of data for northeastern USA[28]. Estimates of nitrate leaching for the 15-year period were based on five years of data collected in this experiment during 1991–95 from intact-core below-ground lysimeters installed in 4 replicates × 3 entry points, for a total of 36 lysimeters (each 0.45 m^2 in area)[29].

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Motion integration in a thalamic visual nucleus

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Thalamic nuclei have long been regarded as passive relay stations for sensory information en route to higher level processing in the cerebral cortex. Recently, physiological and theoretical studies have reassessed the role of the thalamus and it has been proposed that thalamic nuclei may actively participate with cortical areas in processing specific information[1–4]. In support of this idea, we now show that a subset of neurons in an extrageniculate visual nucleus, the lateral-posterior pulvinar complex, can signal the true direction of motion of a plaid pattern, indicating that thalamic cells can integrate different motion signals into a coherent moving percept[5–8]. This is the first time that these computations have been found to occur outside the higher-order cortical areas[5,6,9,10]. Our findings implicate extrageniculate cortico–thalamo–cortical loops in the dynamic processing of image motion, and, more generally, as basic computational modules involved in analysing specific features of complex visual scenes.

The integration of motion signals is usually considered to be a two-stage process[5,11]. The first stage involves the analysis of object features as one-dimensional components, which are integrated at a second stage. It has been argued that the first stage is inherently limited in its coding of local motion signals (the aperture problem[5]), and that the second stage, combining the outputs from the first, is necessary to generate a global percept of an object in motion. This second stage has been attributed to cortical networks, as have all forms of higher-order processing. However, models have been proposed in which thalamic nuclei participate in these processes, interacting closely with the neocortex[1–4,12–14]. A common implication of these models is that cells on both sides of the cortico–thalamic loop have similar higher-order response properties, although there has been no clear demonstration of subcortical neurons responding to higher-order visual stimuli. In well-developed visual systems, the pulvinar region is a likely candidate for a subcortical counterpart to the cortex where a loop involved in the analysis of moving objects could be established. The pulvinar complex represents a higher-order nucleus because it receives its major input from layer V cortical neurons, rather than directly from retinal ganglion cells; it is also in reciprocal communication with virtually all visual and associative cortical areas[15,16]. This region is often associated with visual attention[17,18] and visually guided movement[19], but theories of its function remain speculative[15]. In cats, the physiological response properties in the lateral-posterior pulvinar (LP-pulvinar) complex indicate that these cells code attributes of image motion such as direction, velocity, and the relative motion between an object and its background[20]. On the basis of these response properties and connectivity patterns, we considered that the LP-pulvinar complex could participate in analysing the global motion of complex scenes. We therefore studied the sensitivity of cells in the cat's LP-pulvinar complex to moving plaid patterns. This stimulus comprises two superimposed drifting gratings differing only in orientation. A human observer perceives a single rigid pattern moving unambiguously with a direction and velocity uniquely consistent with the constraints imposed by the motion of the individual components[5,7,8]. At the neuronal level, a cell that is selective for the global motion of the plaid pattern responds with a profile similar to that of a single grating moving in the integrated direction ('pattern'-motion selectivity), rather than

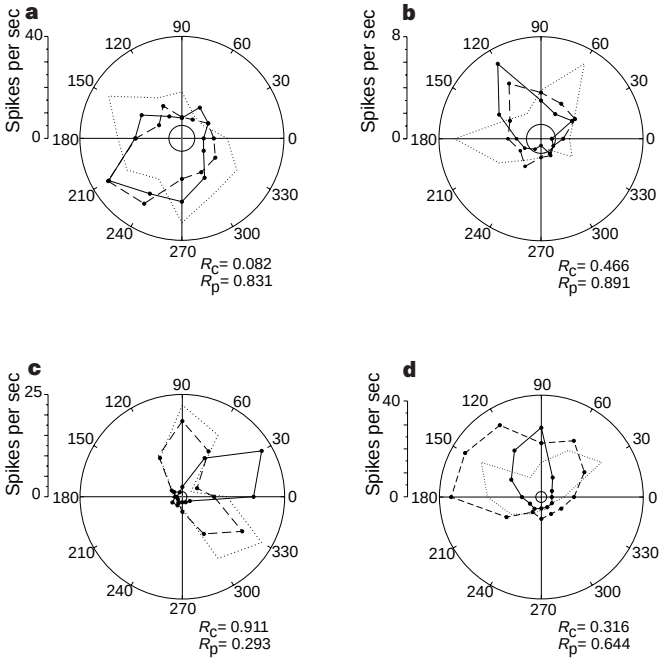

Figure 1 Polar graphs illustrating the responses of LP-pulvinar neurons to gratings (solid line) and plaid patterns (dashed line) drifting in 12 directions of motion. We considered the response to gratings alone as the predicted profile for a truly pattern-motion selective unit. The dotted line represents the predicted response to plaids for a component-motion selective unit. **a**, **b**, Pattern-motion selective neurons. **c**, The response of a component-motion selective cell. **d**, The discharges of an unclassified direction-selective cell. The small central circles represent spontaneous activity levels.

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Friday, 17 September, 1999, 07:21 GMT 08:21 UK

Organic farming can 'feed the world'

By BBC Science's Corinne Podger

Organic farming could produce enough food to feed large populations, according to British scientists at the Festival of Science in Sheffield.

It may be environmentally friendly, but advocates of modern intensive farming methods say that "going organic" will not produce enough food to feed large populations.

But the British team say the lower yields from organic farms can still be profitable once the savings on chemical additives such as fertilisers and machinery are taken into account. And they say organic farming could be viable even in developing countries if the political climate is favourable.

In developed countries, organic food is increasingly in demand. It is perceived by many as being healthier, and free from chemical residues from pesticides and fertilisers.

Although organic farms achieve only 60 to 80% of the yield of high intensity conventional farms, some of these losses can be offset against savings on expensive fertilisers and insecticides.

Organic farms economically viable

Most organic farms in countries like Britain and the United States are still fairly small in size.

Dr Liz Stockdale, of the Institute of Arable Crop Research in England, believes organic farms could be economically viable on a much larger scale, even in developing countries with large populations.

Could organic crops feed the world?

"In less developed countries, countries where the conventional agricultural systems aren't that intensive to start with, we can see that conventional systems and organic systems actually can match yields very closely," she

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said.

Dr Stockdale says this is because conventional farms in poorer countries tend to use less expensive machinery and chemicals, putting them more on a par with organic systems.

Growing the right crops

But she says the lower yields of organic farms in any country could be greatly increased as scientists learn more about controlling insects and disease without chemicals, and find the right crops to suit a particular region's pests and climate.

"One of the main problems isn't getting the total yield, it's getting marketable yield, yield that consumers are quite happy to buy. And that's because quite a bit of that crop is damaged by pests or disease, just on the surface but not affecting the quality for eating, but the way it looks".

"So just improving ways of trapping pests is the one that makes us money."

But Dr Stockdale says farmers can do only so much in producing enough food to feed the world; governments have a role to play as well.

Conventional farms, she says, often produce too much food - leading to produce being grown for human consumption in Western countries frequently being fed to animals.

Until governments tackle the social and political factors involved in poverty and effective food distribution, she says, millions of people will continue to go hungry.

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Organic Apples Win Productivity and Taste Trials
August 10, 2001

A study in the journal *Nature* counters arguments that organic farming systems are less efficient and produce lower yields than conventional farming systems. Conducted by researchers at Washington State University from 1994 to 1999, the study compared organic, integrated and conventional apple orchards and found that while all three systems gave similar apple yields, the organic system had the greatest environmental sustainability, profitability and energy efficiency.

In the study, the organic system did not use synthetic pesticides or fertilizers and relied on compost, mulch, pheromone-mating disruption (PMD), Bacillus thuringiensis and thinning fruit by hand. By contrast, the conventional system used synthetic fertilizers and pesticides, PMD and chemical fruit thinner; the integrated farming system used compost, synthetic fertilizers, mulch and herbicides.

Cumulative yields were comparable and there were no observable differences in physiological disorders or pest and disease damage across the three apple production systems. However, the study found that the organic apple system had the highest soil quality, profitability, energy efficiency and taste appeal. The organic apple system also had the least adverse environmental impact.

Although sustainability is a difficult concept to measure, the researchers included both ecological and economic factors in their analysis. They noted that to be sustainable a farm must produce adequate high-quality yields, be profitable, protect the environment, conserve resources and be socially responsible in the long term. Specifically, the indicators of sustainability used in the study were soil quality, horticultural performance, orchard profitability, environmental quality and energy efficiency.

Organic apples were the most profitable due to price premiums and quicker investment return. The price premiums reflect consumer willingness to pay extra for organically grown produce. Production costs of organic and conventional systems varied by year. In the long term, the organic apple system recovered initial costs faster than the conventional system. The study projected that the organic system would break even economically (net returns equaling costs) after nine years, but that the conventional system would break even only after fifteen years.

Despite higher labor needs, the organic system expended less energy on fertilizer, weed control and biological control of pests than the conventional and integrated systems. By using the least

amount of inputs overall, the organic system was the most energy efficient of the three systems.

A consumer taste test found that organic apples were less tart at harvest than both conventional and integrated apples. They were also found to be sweeter than conventional apples after six months of storage.

The study's data indicate that the organic system ranked first in environmental and economic sustainability, the integrated system second and the conventional system last. The authors suggest that perennial food crops such as apples may prove to be more sustainable to produce over the long term than annual crops. Perennial crops currently comprise a significant portion of the world's agricultural production.

Organic farming became one of the fastest growing segments of U.S. and European agriculture during the 1990s.

Sources: John P. Reganold, Jerry D. Glover, Preston K. Andrews and Herbert R. Hinman, "Sustainability of three apple production systems," *Nature* Vol. 410, April 19, 2001; Reuters "Organic Apples Get Top Rating in Comparative Study," April 18, 2001.

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Costs & Benefits

"The Greener Revolution"

Editorial
New Scientist
February 3, 2001

IT SOUNDS like an environmentalist's dream. Low-tech "sustainable agriculture", shunning chemicals in favour of natural pest control and fertiliser, is pushing up crop yields on poor farms across the world, often by 70 per cent or more. But it's no dream. That's the claim being made in the biggest ever survey of green-minded farming (see p 16). The findings will make sobering reading for people convinced that only genetically modified crops can feed the planet's hungry in the 21st century.

The gains are greatest among poor farmers. This is not surprising. The high-tech green revolution that has doubled global food production in little more than a generation was always designed for big mechanised farms on the best land, using capital to buy pesticides and fertilisers the new high-yielding plant varieties need. It was never a blueprint for working the poorer land, or helping illiterate farmers with plenty of labour and ingenuity but little capital.

Yet over the past 30 years, these farmers have been pushed into half-heartedly adopting this revolution. While some have gained, this hand-me-down technology has not served them well.

The survey shows there is a better way. A new science-based revolution is gaining strength built on real research into what works best on the small farms where a billion or more of the world's hungry live and work.

For some, talk of "sustainable agriculture" sounds like a luxury the poor can ill afford. But in truth it is good science, addressing real needs and delivering real results. For too long it has been the preserve of environmentalists and a few aid charities. It is time for the major agricultural research centres and their funding agencies to join the revolution.

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"An ordinary miracle"

Fred Pearce
New Scientist
February 3, 2001

ACROSS east Africa, thousands of farmers are planting weeds in their maize fields. Bizarre as it sounds their technique is actually raising yields by giving the insect pests something else to chew on besides maize. "It's better than pesticides, and a lot cheaper," said Ziadin Khan, whose idea it is, as he showed me round his demonstrations plots at the Mbita Point research station on the shores of Lake Victoria in Kenya.

"And it has raised farm yields round here by 60 to 70 per cent."

His novel method of fighting pests is one of a host of low-tech innovations boosting production by 100 per cent or more on millions of poor Third World farms in the past decade. This "sustainable agriculture" just happens to be the biggest movement in Third World farming today, dwarfing the tentative forays in genetic manipulation. It seems peasant farmers have a long way to go before they exhaust the possibilities of traditional agriculture and have to place their futures in the hands of genetic engineers. In east Africa, maize fields face two major pests, and Khan has a solution to both. The first is an insect called the stem borer. True to its name, its larvae eat their way through a third of the region's maize most years. But Khan discovered that the borer is even fonder of a local weed, napier grass. By planting napier grass in their fields, farmers can lure the stem borers away from the maize - and into a honey-trap. For the grass produces a sticky substance that traps and kills stem borer larvae. The second major pest is "Striga", a parasitic plant that wrecks dollar 10 billion worth of maize crops every year, threatening the livelihoods of 100 million Africans.

Weeding "Striga" is one of the most time-consuming activities for millions of African women farmers, says Khan. But he has an antidote: another weed, called "Desmodium". "It seems to release some sort of chemical that "Striga" doesn't like. At any rate, where farmers plant "Desmodium" between rows of maize, "Striga" won't grow."

Khan's cheap fixes for "Striga" and stem borer are spreading like wildfire through the fields of east Africa.

Trials on more than two thousand farms are finished. "It's out of our hands now," says Khan's boss, Hans Herren, who is the director of the International Centre for Insect Physiology and Ecology in Nairobi. "The ideas are being taken up by farmers in countries such as Ethiopia where we have never worked." Khan, meanwhile, is going back to the wastelands of Kenya looking for more grasses to kill common pests. His miracle is one of dozens of different strategies transforming the lives of millions of poor farmers on small farms across the planet. They replace pesticides with natural predators, and fertilisers with animal dung, crop wastes and plants that fix nitrogen from the air. They choose artful combinations of crops that maximise nature's bounty. In January this year the world's largest study into sustainable agriculture was published. Jules Pretty of the University of Essex analysed more than 200 projects in 52 countries. He found that more than four million farms were involved, covering an area the size of Italy - 3 per cent of fields in the Third World. And, most remarkably, average increases in crop yields were 73 per cent. Sustainable agriculture, Pretty concludes, has most to offer to small farms that cannot afford chemical solutions to their problems. Its methods are "cheap, use locally available technology and often improve the environment. Above all they most help the people who need help the most - poor farmers and their families, who make up the majority of the world's hungry people."

And, hardly surprisingly, many of the successful techniques are now being adopted by agribusiness. Raising fish in rice paddies, for instance, began in Bangladesh but is now developing into a global industry. Khan's alternative pesticides are likewise finding a potential market on large farms anxious to cut the cost of conventional pesticides.

The success of sustainable agriculture is dispelling the myth that modern techno-farming is the most productive method, says Miguel Altieri of the University of California, Berkeley. "In Mexico, it takes 1.73 hectares of land planted with maize to produce as much food as one hectare planted with a mixture of maize, squash and beans."

The difference, he says, comes from "the reduction of losses due to weeds, insects and diseases and a more efficient use of the available resources of water, light and nutrients". Monocultures breed pests and waste resources, he says. And some experts think GM crops will pale by comparison with sustainable agriculture, at least for the time being. "I don't see GMs making an impact on food production in Africa within the next 10 or 15 years," says Herren. "What Africa most needs is investment in 'soft' biotechnologies such as alternative natural pesticides."

Researchers from the Association Tefy Saina, a Madagascan group working for local farmers, were looking for ways to boost rice yields on small farms. They decided to make the best use of existing strains rather than track down a new breed of super-rice. Through trial and error, Henri de Laulaine, a local Catholic priest, had stumbled on a system that raises typical rice yields from 3 to 12 tonnes per hectare. His trick is to transplant seedlings earlier and in small numbers so that more survive; to keep paddies unflooded for much of the growing period; and to help the plants grow using compost rather than chemical fertilisers.

Scientists have been sceptical about the ability of poor farmers to achieve such spectacular results, says the association's Sebastien Rafaralahy. Nonetheless, de Laulaine's idea has spread like wildfire: 20,000 have adopted the idea in Madagascar alone. Following a collaboration with Cornell University in Ithaca, New York, the system has been transplanted to the Asian heartland of rice cultivation. In tests, China, Indonesia and Cambodia all managed to raise their rice yields. Few countries have switched wholesale to sustainable agriculture. But Cuba has. The collapse of the Soviet Union in 1990 cut off cheap supplies of grain, tractors and agrochemicals. Pesticide use halved overnight, as did the calorie intake of its citizens. The cash-strapped country was forced to embrace low- input farming or starve. Today, says Fernando Funes of the country's Pasture and Fodder Research Institute, teams of oxen replace the tractors, and farmers have adopted organic methods, mixing maize with beans and cassava and doubling yields in the process, helping average calorie intake per person rise back to pre-1990 levels. Worldwide, one of the most widely adopted sustainable techniques has been to throw away the plough, the ultimate symbol of the farmer. Ploughing aerates the soil, helping rot weeds and crop residues. But it can also damage soil fertility and increase erosion. Now millions of Latin American farmers have decided it isn't worth the effort. A third of Argentina's farms no longer use the plough. Instead, they fight weeds by planting winter crops such as black oats, or by spraying a biodegradable herbicide such as glyphosate.

"The farmers saw results in a short time - reduced costs, richer soils, higher grain yields and increased income," says Lauro Bassi of EPAGRI, the agricultural research institute in Santa Catarina state, southern Brazil, which has been promoting the idea. Zero-tillage also benefits the planet in general. Unploughed soils hang on to carbon that would otherwise escape into the air as carbon dioxide when organic matter rots. A one-hectare field left unploughed can absorb up to a tonne of carbon every year, says Pretty, making soils a vital element in preventing global warming.

Sustainable agriculture is no magic bullet for feeding the world. It is an approach rather than a blueprint. Small farms with low yields stand to benefit the most and agribusiness the least. But it does offer an alternative for the millions of small farms that have plenty of hands to work the land but not the skills or financial resources to adopt conventional mechanised farming. Pretty says: "Things are happening that are very exciting. If it catches on we can make substantial inroads in reducing the 800 million people who still go to bed hungry every night." Perhaps the most dramatic evidence of its success so far, he adds, is that little of the extra produce ever finds its way to distant supermarkets while the farmers starve. Most of it is eaten by the people who grow it.

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Reducing Food Poverty with Sustainable Agriculture:

A Summary of New Evidence

Executive Summary

Jules Pretty and Rachel Hine, University of Essex
SAFE-World Research Project
February 2001

The Scale of the Challenge

1. Over the past 40 years, per capita world food production has grown by 25%, and food prices in real terms have fallen by 40%. Between the early 1960s and mid-1990s, average cereal yields grew from 1.2 t/ha to 2.52 t/ha in developing countries whilst total cereal production has grown from 420 to 1176 million tonnes per year.
2. Yet the world still faces a fundamental food security challenge. Despite steadily falling fertility rates and family sizes, the world population is expected to grow to 8.9 billion by 2050. By this time, 84% of people will be in those countries currently making up the `developing' world.
3. At the year 2000, there were 790 million people hungry. Despite progress on average per capita consumption of food (up 17% in the past 30 years to 2760 kcal), people in 33 countries still consume under 2200 kcal per day. Although a combination of increased production and more imports will mean per capita consumption will increase to about 3000 kcal per day by 2015, food insecurity and malnutrition will still persist.

Changes in Demand for Food

4. Food demand will both grow and shift in the coming decades for three reasons:
   i. increasing numbers of people (until at least the mid-late 21st century) mean the absolute demand for food will increase;
   ii. increasing incomes mean people will have more purchasing power (even though many will remain on no more than $1/day);
   iii. increasing urbanisation means people will be more likely to adopt new diets, particularly consuming more meat - demand is expected to double by 2020 in developing countries, and increase by 25% in industrialised countries, helping to drive a total and per capita increase in demand for cereals (it takes 7 kg of feed to produce 1 kg of feedlot beef, 4 kg for 1kg of pork, and 2 kg for 1 kg of poultry).

Who Needs the Food the Most?

1. With gloomy predictions about increasing numbers of people, growing demand for cereals and meat, and stubbornly persistent hunger and poverty, an important question relates to who needs an increase in food the most. It is clear that adequate and appropriate food supply is a necessary condition for eliminating hunger and food-poverty.
2. But increased food supply does not automatically mean increased food security for all. What is important is who produces the food, who has access to the technology and knowledge to produce it, and who has the purchasing power to acquire it.
3. There is now increasing agreement that more attention needs to be paid to maternal and child nutrition. Low birth weight is a key factor in child malnutrition and premature death, which is, in turn, caused by a mother's poor nutrition before conception and during pregnancy. In the year 2000, 27% of pre-school children (some 182 million) in developing countries had stunted growth (where height is less that two standard deviations for the age). This is due both to poor quantity and diversity of foods, leading to widespread deficiencies of vitamins and minerals.

4. Women and children need more food – but there is also a need for better female education, family health improvements, and status improvements for women relative to men. Women are disadvantaged in agricultural systems, producing up to 80% of food, but owning little land and with access to less than 10% of credit and extension advice.
5. The conventional wisdom is that, in order to double food supply, we need to redouble efforts to modernise agriculture. After all, it has been successful in the past. But there are doubts about the capacity of such systems to reduce food poverty. The poor and hungry need low-cost and readily-available technologies and practices to increase local food production.

Choices for Agricultural Development

6. There are three possible choices for agricultural development:

- expand the area of agriculture, by converting new lands to agriculture, but with the result that services from forests, grasslands and other areas of important biodiversity are lost;
- increase per hectare production in agricultural exporting countries (mostly industrialised), so that food can be transferred or sold to those who need it;
- increase total farm productivity in developing countries which are most going to need the food.

1. The success of modern agriculture in recent decades has often masked significant externalities, affecting both natural capital and human health, as well as agriculture itself. Environmental and health problems associated with agriculture have been increasingly well-documented, but it is only recently that the scale of the costs has come to be appreciated.
2. In this research, we explore the options offered by a more sustainable agriculture, and draw some tentative conclusions about the value of increasing food production based on locally-available resources in developing countries.
3. The central issues are, therefore, i) the extent to which farmers can improve food production with cheap, low-cost, locally-available technologies and inputs, and ii) whether they can do this without causing further environmental damage.

Sustainable Agriculture – What is it?

4. A more sustainable agriculture seeks to make the best use of nature's goods and services as functional inputs. It does this by integrating natural and regenerative processes, such as nutrient cycling, nitrogen fixation, soil regeneration and natural enemies of pests into food production processes. It minimises the use of non-renewable inputs (pesticides and fertilizers) that damage the environment or harm the health of farmers and consumers. It makes better use of the knowledge and skills of farmers, so improving their self-reliance. And it seeks to make productive use of social capital - people's capacities to work together to solve common management problems, such as pest, watershed, irrigation, forest and credit management.
5. Sustainable agriculture technologies and practices must be locally-adapted. They emerge from new configurations of social capital (relations of trust embodied in new social organisations, and new horizontal and vertical partnerships between institutions) and human capital (leadership, ingenuity, management skills and knowledge, capacity to experiment and innovate). Agricultural systems with high social and human capital are able to innovate in the face of uncertainty.
6. Sustainable agriculture jointly produces food and other goods for farm families and markets, but it also contributes to a range of public goods, such as clean water, wildlife, carbon sequestration in soils, flood protection, landscape quality. It delivers many unique non-food functions that cannot be produced by other sectors (eg on-farm biodiversity, groundwater recharge, urban to rural migration, social cohesion).

SAFE-World Project Methodology

7. The aim of the SAFE-World research project was to audit recent worldwide progress towards sustainable agriculture, and assess the extent to which such projects / initiatives, if spread on a much larger scale, could feed a growing world population that is already substantially food insecure.
8. We developed a four-page questionnaire as the main survey instrument for projects / initiatives. It addressed i. key impacts on total food production, and on natural,

social and human capital; ii. the project / initiative structure and institutions; iii. details of the context and reasons for success; iv. spread and scaling-up (institutional, technical and policy constraints).

9. The questionnaire was centred on an assets-based model of agricultural systems, and was developed to understand both the role of these assets as inputs to agriculture and the consequences of agriculture upon them. The questions were also formulated with regard to the nine types of sustainable agriculture improvement identified as the conceptual base for this project (see below).
10. We collated all returned questionnaires and secondary material, and added this to the country databases. All datasets were re-examined to identify gaps and ambiguities, and correspondents contacted again to help fill these. We established trustworthiness checks by engaging in regular personal dialogue with respondents, through checks with secondary data, and by critical review by external reviewers and experts.
11. We rejected cases from the database on several grounds: i) where there was no obvious sustainable agriculture link; ii) where participation was for direct material incentives (as there are doubts that ensuing improvements persist after such incentives end); iii) where there was heavy or sole reliance on fossil-fuel derived inputs for improvement, or on their targeted use alone (this is not necessarily to negate these projects, but to indicate that they are not the focus of this research); iv) where the data provided in the questionnaire has been too weak; v) where findings were unsubstantiated by the verification process.
12. However, we have undoubtedly missed many novel, interesting and globally-relevant projects / initiatives. Just because this research project is global in scope does not mean we have been able to be comprehensive. We therefore present conservative estimates of what has been achieved, over what area, and by how many farmers.

Summary of Projects/Initiatives on Database

13. At October 1st 2000, the sustainable agriculture database contained information on 208 cases from 52 countries. This is the largest known survey of worldwide sustainable agriculture.
14. In these projects / initiatives, some 8.98 million farmers have adopted sustainable agriculture practices and technologies on 28.92 million hectares. There are 960 million hectares of arable and permanent crops in Africa, Asia and Latin America, and so sustainable agriculture is present on at least 3.01% of this land.
15. The largest country representations in the database are India (23 projects / initiatives); Uganda (20); Kenya (17); Tanzania (10); China (8); the Philippines (7); Malawi (6); Honduras, Peru, Brazil, Mexico, Burkina Faso and Ethiopia (all 5); and Bangladesh (4). We estimate that some 95% of these improvements have occurred since the beginning of the 1990s. We also believe that the data collected on numbers of farmers and hectares are conservative estimates of what has been achieved.
16. We scored all projects / initiatives according to their use of the nine types of improvement for sustainable agriculture (see Box):

> 1: Better use of locally-available natural resources – 88% of projects
>
> 2: Intensify microenvironments in farm system (gardens, orchards, ponds) – 21% of projects
>
> 3: Diversify by adding new regenerative components – 59% of projects
>
> 4: Better use of non-renewable inputs and external technologies – 18% of projects
>
> 5: Social and participatory processes leading to group action – 55% of projects
>
> 6: Human capital building through continuous learning programmes – 92% of projects
>
> 7: Access to affordable finance (credit, grants, subsidies) – 17% of projects
>
> 8: Added value through processing to reduce losses and increase returns – 12% of projects
>
> 9: Adding value through direct or organised marketing to consumers – 15% of projects

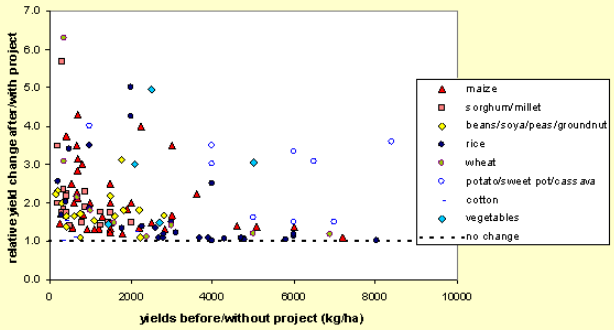
17. These last findings about types 7-9 are significant, as clearly more attention is still being paid to on-farm and in-community improvements, rather than on finding ways to link farmers to markets and consumers, and to add value to produce.

How Farm Productivity is Increasing

18. The evidence from the 208 projects suggests improvements in food production arise from one or more of five different mechanisms:
    i. intensification of a single component of farm system (with little change to the rest of the farm) - such as home garden intensification, vegetables on rice bunds, and introduction of fish ponds or a dairy cow;
    ii. addition of a new productive element to a farm system, such as fish in rice or trees on boundaries, which provides a boost to total farm food production, but which do not necessarily affect cereal productivity;
    iii. better use of natural capital, especially water (by water harvesting, irrigation scheduling, water stressing), and land (by reclamation of formerly unproductive land), so leading to additional new dryland crops and / or increased supply of additional water for irrigated crops (so increasing cropping intensity);
    iv. improvements in per hectare yields of staples through introduction of new regenerative elements into farm systems (eg legumes). The proportional yield increases are greatest in rainfed systems (though starting from a lower base) than in irrigated systems;
    v. improvements in per hectare yields through introduction of new and locally-appropriate crop varieties and animal breeds.

1. Therefore a sustainable agriculture project may be substantially improving domestic food consumption or increasing local food barters or sales through biointensive gardens or fish in rice fields, or better water management, without affecting the per hectare yields of cereals.

Figure 1. Sustainable agriculture projects/initiatives - crop yield changes (89 projects)



2. However, 91 projects (139 entries of crop x projects combinations) do contain data on yield changes. Figure 1 shows details of the increases in per hectare productivity in systems with yields less than 2500 kg / ha. This indicates that sustainable agriculture can lead to substantial increases in per hectare food production. The proportional yield increases are generally:

- 50-100% for rainfed crops, though considerably greater in a few cases;
- 5-10% for irrigated crops, through starting from a higher absolute yield base.

1. In order to understand the changes in food production occurring within these sustainable agriculture projects, we divided the world's farm systems into 13 major types of agroecosystems. In each of these systems, we summarise the current situation, the kinds of improvements achieved with sustainable agriculture (if any), and the challenges for further improvements.

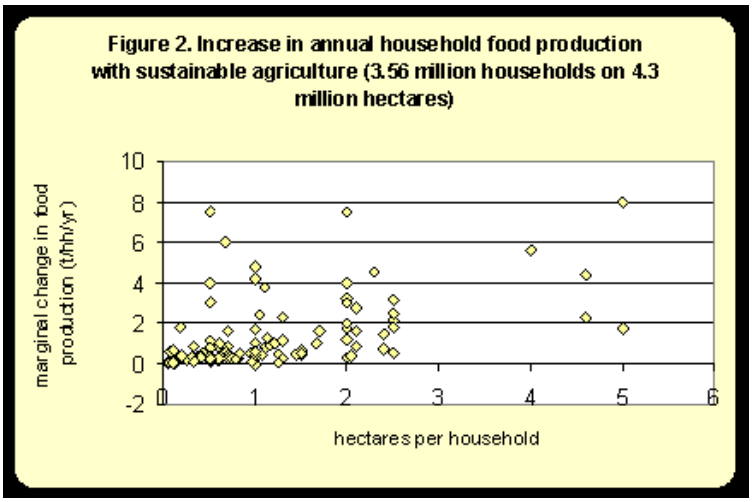
Changes in Food Production per Household

2. We calculated the marginal increase in food production per household for those 96 projects with data on reliable yields, area and numbers of farmers. We separated out the four entries for large commercial farmers in Latin America (Argentina, Brazil, Paraguay) from the remaining farms with average sizes of less than five hectares.
3. A rural household needs the following to be food secure:

i. an adequate supply of food, either grown on the farm or bought with earned income, and measured in kcal or kg of cereal equivalent;

ii. a variety of food containing the necessary mix of protein, carbohydrate and fat, together with vitamins and minerals, for a healthy diet;

iii. the appropriate quantity and diversity throughout the year, particularly during months of shortage and / or insecurity.



1. Most sustainable agriculture projects and initiatives report significant increases in household food production - some as yield improvements, and some as increases in cropping intensity or diversity of produce (Figure 2). The evidence shows that:

   i. for the 4.42 million farmers on 3.58 million hectares, average food production per household increased by 1.71 tonnes per year (an increase of 73%);

   ii. for the 146,000 farmers on 542,000 hectares cultivating roots (potato, sweet potato and cassava), the increase in food production was 17 tonnes per year (an increase of 150%);

   iii. for the larger farms in Latin America (ave. size = 90 ha / farm), total production increased by 150 tonnes per household (an increase of 46%).

1. Few projects, however, report surpluses of food being sold to local markets. We suggest that this is because of a significant elasticity of consumption amongst rural households experiencing any degree of food insecurity. As production increases, so domestic consumption also increases, with direct benefit for health, particularly of women and children.

2. Despite this, several projects have reported surpluses and regional improvements to food production. Once again, though, we want to emphasise the extraordinary productive potential of small patches on farms, and the degree to which they can improve domestic food security. These areas can also see productivity increase over time, as the natural and human capital assets increase.

Reasons for Success/Constraints on Spread

3. We analysed the completed questionnaires and project data to explore i) stated reasons for success in projects and initiatives; and ii) limits and constraints on the further spread of technologies, practices and approaches. We used a common framework of seven key indicators, each of which was then subdivided, giving 17 indicators for reasons for success and 21 indicators for constraints.

4. We conclude that sustainable agriculture successes have been founded mainly upon:

   i. appropriate technology adapted by farmers' experimentation;

   ii. a social learning and participatory approach between projects and farmers;

   iii. good linkages between projects / initiatives and external agencies, together with the existence of working partnerships between agencies;

   iv. presence of social capital at local level.

1. We conclude that if sustainable agriculture is to spread to larger numbers of farmers and communities, then future attention needs to be paid to:

   i. ensuring the policy environment is enabling rather than disabling;

ii. investing in infrastructure for markets, transport and communications;
iii. ensuring government agencies in particular are supportive of local sustainable agriculture projects and initiatives;
iv. developing social capital within rural communities and between external agencies.

Impacts on Rural Livelihoods

1. The empirical evidence suggests that the nine types of sustainable agriculture improvements have a variety of positive effects on people's livelihoods. A selection of the impacts reported in the SAFE-World projects and initiatives include:
   i. improvements to natural capital, including increased water retention in soils; improvements in water table (with more drinking water in the dry season); reduced soil erosion combined with improved organic matter in soils, leading to better carbon sequestration; and increased agro-biodiversity
   ii. improvements to social capital, including more and stronger social organisations at local level; new rules and norms for managing collective natural resources; and better connectedness to external policy institutions
   iii. improvements to human capital, including more local capacity to experiment and solve own problems; reduced incidence of malaria in rice-fish zones; increased self-esteem in formerly marginalised groups; increased status of women; better child health and nutrition, especially from more food in dry seasons; and reversed migration and more local employment.

Labour Markets and Migration Patterns

1. At some locations, sustainable agriculture has had a significant impact on labour markets. Some practices result in increased on-farm demand for labour (eg water harvesting in Niger), whilst others actually reduce labour demand (eg zero-tillage in Brazil). Some result in the opening up of whole new seasons for agricultural production, particularly in dryland contexts, through improved harvesting of rainfall, leading to much greater demand for labour.
2. Migration reversals can occur when wage labour opportunities increase as part of the project (eg watershed improvements), when more productive agriculture leads to higher wages and employment, when there are higher returns to agriculture, and when there are overall improvements in village conditions, such as infrastructure and services.

Dietary and Reproductive Health

3. Sustainable agriculture has the potential directly and indirectly to influence the health of rural people. In the first instance, improved food supply throughout the year has a fundamental impact on health, which in turn allows adults to be more productive, and children to attend school and still be able to concentrate on learning. In many projects, for example, raised beds in kitchen gardens have improved domestic food supply by producing a year-round supply of vegetables – and children are often the main beneficiaries. In some cases, a more sustainable agriculture can also help to remove threats to health in the environment - such as consumption of mosquito larva by fish in rice fields in China.
4. Sustainable agriculture can also have an indirect effect on reproductive health. Where women are organised into groups, such as for microfinance delivery (credit and savings), livestock raising or watershed development, such social capital creation offers opportunities or `entry points' for other sectors to interact closely with women.

Large Farms, Small Farms and Landless Families

5. In certain circumstances, sustainable agriculture practices appear to be currently more accessible to larger farmers - particularly the zero-tillage systems in southern Latin America. However, evidence from Paraguay and Brazil also suggests that many small farmers adopt and adapt elements of these practices if the process if interaction is participatory.
6. In other contexts, sustainable agriculture has first been adopted by small farmers, and is only now spreading to larger ones once they have seen the success. In Bangladesh, the rice-fish and rice-IPM technologies were adopted by very small farmers first, with larger farmers attracted only when success had been proven.
7. Sustainable agriculture can result in improvements in livelihoods for landless families and the core poor in three ways: improvements to labour markets, improved access to land

through land reform, or changed social norms that encourage greater equity and sharing.

Social Learning Processes to Understand and Manipulate Megabytes in Fields

8. Social learning is a vital part of the process of adjustment in sustainable agriculture projects. The conventional model of understanding technology adoption as a simple matter of diffusion, as if by osmosis, no longer holds. But the alternative is neither simple nor mechanistic. It involves building the capacity of farmers and their communities to learn about the complex ecological and biophysical complexity in their fields and farms, and then to act in different ways. The process of learning, if it is socially-embedded, provokes changes in behaviour and can bring forth a new world.
9. The metaphor used here for this new sustainability science is to conceive of fields as being full of megabytes of information – yet we collectively lack the operating system to understand and transform this information. This is information about pest-predator relationships, about moisture and plants, about soil health, and about the chemical and physical relationships between plants and animals on farm. These are subject to manipulation – and farmers who understand some of this information, and who are confident about experimentation, have the components of an advanced operating system. Most of the time, though, this information remains unavailable.
10. The empirical evidence tells us two important things. Social learning leads to greater innovation together with increased likelihood that social processes producing these technologies are likely to persist.

Improvements to Soil Health

11. The most important part of any agricultural system is the soil. It is the fundamental capital asset. When it is in poor health, it cannot sustain a productive agriculture. Many agricultural systems are under threat because soils have been damaged, eroded or simply ignored during the process of agricultural intensification.
12. Most sustainable agriculture projects and initiatives seek both to reduce soil erosion and to make improvements to soil physical structure, organic matter content, water holding capacity and nutrient balances. This can be achieved through the adoption of a wide variety of physical and biological soil conservation measures, use of legumes and green manures and / or cover crops, incorporation of phosphate-fixing plants into rotations, use of composts and animal manures, adoption of zero-tillage, and use of inorganic fertilizers.
13. One sustainable agriculture technology to spread at extraordinary speed is zero- or minimal tillage. In Brazil, there were 1 million hectares under *plantio direto* (zero-tillage) in 1991; by 1999, this had grown to about 11 million hectares in three southern states. In Argentina, there were 9.2 million hectares under ZT in 1999 - up from less than 100,000 ha in 1990. ZT has resulted in better input use, water retention, management by farmers, diverse rotations, break crops for weed control (eg ray and black oats between maize / soyabeans) and use of green manures and cover crops. ZT also cuts erosion and water run-off, so reducing water pollution.
14. This adoption of sustainable agriculture points to a large public good being created when soil health is improved with increased organic matter. OM contains carbon, and it is now recognised that soils can act as carbon sinks or sites for carbon sequestration. Soils in temperate regions can accumulate at least 100 kg C / ha / year, and in the tropics 200-300 kg C / ha / year. Agroecosystems using green manures and / or zero-tillage can accumulate more – up to 1000 kg / ha / year. Such increases can accumulate over about 50 years before reaching equilibrium.

Pest Control with Minimal or Zero Pesticides

15. Many sustainable agriculture projects have reported very large reductions in pesticide use following the adoption of IPM through farmer field schools in rice agroecosystems. In Vietnam, farmers cut the number of sprays form 3.4 to 1 per season, and in Sri Lanka from 2.9 to 0.5 per season.
16. Novel research in East Africa has identified the pest management benefits of some farm biodiversity. Researchers from ICIPE and IACR-Rothamsted have found that the chemical cues (semiochemicals) produced by maize when fed upon by stem borers, and which cause increased foraging and attack by parasitic wasps, are also released by a variety of grasses. Working closely with farmers, they have identified a variety of `push-pull' technologies that repel stem borers from maize, and attract them to forage grasses, particularly napier, sudan and molasses grass. In western Kenya, 2000 farmers have adopted the `*vutu sukuma*'

system (push-pull), with the result that maize yields have improved by 60-70% in 1998-99.

Making Better Use of Water

17. Water is a clear constraint in many rainfed contexts and, when better harvested and conserved, may be the key factor leading to improved agricultural productivity through increased yields, allowing new lands to be brought under farming, and increased cropping intensity on existing lands.
18. Water harvesting can lead to improved production in both drylands and extra crops in wetlands. Improved management of water in irrigated systems can also make a significant difference to outcomes.

Adding Value and Marketing - the Forgotten Components

19. The empirical evidence indicates quite clearly that there is relatively little attention to adding value and / or marketing in these sustainable agriculture projects (only 12-15% of the 208 projects). A variety of options are available to increase the returns to families from their production, either by reducing losses to pests (better storage and treatment) and inefficient processes (eg fuel-saving stoves); or by adding value before sale or use (conversion of primary products through processing). Adding value through direct or organised marketing may involve improvements to physical infrastructure (eg roads, transport); or through direct marketing and sales to consumers (thus cutting out wholesalers and `middlemen').

Confounding Factors

20. A more sustainable agriculture which improves the asset base can lead to rural livelihood improvements: people can be better off, have more food, be better organised, have access to external services and power structures, and have more choices in their lives. However, most contexts will see the emergence of critical trade-offs and contradictions. The use of one asset can result in the depletion of another – building a road for marketing near a forest can result in loss of natural capital, as it also aids timber extraction.
21. In some cases, progress in one component of a farm system may cause secondary problems. For example, projects may be making considerable progress on reducing soil erosion and increasing water conservation through adoption of zero-tillage, but still continue to rely on applications of herbicides. In other cases, improved organic matter levels in soils may lead to increased leaching of nitrate to groundwater.
22. There will also be new winners and losers with the emergence of sustainable agriculture on a significant scale. This model for farming systems implies a limited role for agro-chemical companies, who would not be predicted to accept such losses of market lightly.
23. The globalisation of world agriculture will provoke further changes. More control of the world food systems will be centralised in fewer and larger private companies. This centralisation could be good, with companies influencing whole supply chains, but is only likely to happen if companies have good ethical and sustainable bases for operations. The effects on small farmers are more likely to be severe than beneficial.

On Policies for Sustainability

24. Several things are now clear with respect to sustainable agriculture:
    i. The technologies and social processes for local level sustainable agriculture are well-tested and established;
    ii. The social and institutional conditions for spread are less well-known, but have been established in several contexts, leading to very rapid spread in the 1990s;
    iii. The political conditions for the emergence of supportive policies are least well established, with only a very few examples of real progress.

1. The past decade has seen considerable global recognition of the need for policies to support sustainable agriculture. In a few countries, this has been translated into supportive and integrated policy frameworks. In most, however, sustainable agriculture policies remain at the margins, with recognition of need not yet translated into actual policies. Although almost every country would now say it supports sustainable agriculture, the evidence points towards only patchy reforms. Only two countries have given explicit national support for sustainable agriculture – Cuba and Switzerland.
2. A much larger number of countries have reformed elements of agricultural policies through new regulations, incentives and / or environmental taxes, and administrative

mechanisms, and these are having considerable though partial effect. Sustainable agricultural systems can be both economically, environmentally and socially viable, and contribute positively to local livelihoods. But without appropriate policy support, they are likely to remain at best localised in extent, and at worst simply wither away.

Concluding Comments

3. This empirical study has revealed very promising advances in the adoption and spread of sustainable agriculture. The 208 projects / initiatives show clear increases in food production over some 29 million hectares, with nearly 9 million households benefiting from increased food production and consumption.
4. These increases are not yet making a significant mark on national statistics, as we believe there is a significant elasticity of consumption in many rural households. They are eating the increased food produced, or marketing small surpluses to other local people.
5. We cannot, therefore, yet say whether a transition to sustainable agriculture, delivering increasing benefits at the scale occurring in these projects, will result in enough food to meet the current food needs of developing countries, the future basic needs after continued population growth, and the potential demand following adoption of more meat-rich diets.
6. Even the substantial increases reported here might not be enough. However, there is scope for considerable confidence, as the evidence also indicates that productivity dividends can grow with increasing number of improvements, and that productivity increases steadily over time if natural, social and human capital are accumulated.
7. Sustainable agriculture can be complementary for rural people's livelihoods. It can deliver increases in food production at relatively low cost, plus contribute to other important functions. Were these approaches to be widely adopted, they would make a significant impact on rural people's livelihoods, as well as on local and regional food security.

Sustainable agriculture clearly does not have all the solutions, but great progress has been made in recent years. With further explicit policy and institutional support, particularly through national policy reforms, these benefits to food security and attendant improvements to natural, social and human capital could spread to much larger numbers of farmers and rural people in the next decade.

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47 Portraits of Sustainable Agriculture Projects and Initiatives

(from Pretty and Hine, 2001)

LATIN AMERICA

1. Argentina: No or Zero-till farming

Zero- or No-Till is a farming system that replaces traditional inversion ploughing. After harvest, the crop residues are left on the field as protection against soil erosion. At planting, the seed (and fertilizer, if required) is slotted into a groove cut into the surface of the soil. Weeds are often, but not always, controlled with herbicides. This means that the soil surface is always covered, and the soil itself never inverted. Farmers use a range of IPM, rotational and precision methods for pest and nutrient management. For example, black oats are now commonly used in the rotation during winter for both soil cover and weed suppression. Other legume cover crops are used to improve nitrogen supplies.

In Argentina, ZT was first tested by farmers in the late 1980s, and by 1990, there were about 100,000 ha of ZT. The 1990s, however, saw remarkable growth in the technology – rising to some 7.3 million hectares in 1999, and covering 30% of all Argentinian arable land. ZT has also spread rapidly in Paraguay and southern Brazil over the same period.

There are several reasons for this rapid spread:

i. significant private benefits for farmers – yields of maize have grown 37% from 2 to 3.5-4 t/ha with ZT, and soya 11% to 2.47 t/ha. Costs have fallen through reduced energy use, more efficient use of inputs, reduced demand for labour (from $50-70 to $30 per ha), and improved farm assets through increased organic matter content in soils, better pest control and improved water retention;

ii. significant public environmental benefits, through reduced soil erosion and water pollution (of pesticides and nitrate), and increased carbon sequestration in soils;

iii. direct support and promotion by farmers organisations themselves, in particular AAPRESID (the Argentinian No Till farmers' organisation) – as Roberto Peiretti puts it: *"the adoption of NT in Argentinian and neighbouring countries was a farmer-led movement… [and] attributed to the common sense of farmers and their ability to detect new economic, physical and other advantages of the system."* Local ZT farmer research and extension groups have been formed, and these linked to regional and national groups. Such coalitions of farmers have been critical in the continued development, adaptation and spread of ZT technology.

Sources: Roberto Peiretti, Don Reicosky; Peiretti, 2000

2. Bolivia: PRODINPO (Integrated development programme, World Neighbors, Northern Potosí)

World Neighbors has been working in the high mountains of Bolivia (2800-4000 masl) in Northern Potosí on improving potato productivity sine the 1980s. The sandy loam soils suffer from acute erosion, and high population densities have forced cultivation of slopes of up to 50 degrees. High rates of non-literacy, a lack of agricultural research and extension outreach, and deep local suspicion posed severe challenges for the project. In addition, the areas infant mortality rate was 200/1000; maternal mortality 100/1000, and average life span a mere 36 years.

At first the project sought to improve livestock and maize production. But after failures, farmers asked them to focus on potatoes. Their interest was in testing new varieties that might help to improve food security using traditional agricultural practices. Crop performance varies dramatically from one hillside to another, and from one ravine to another, and so learning to account for this variability was a central part of the project – which set out to build farmers' own capacity to experiment with new technologies, and to adapt them to their own circumstances. Communities elect their own farmer promoters to help spread lessons learned as well as be the conduit for improved training.

Farmers have evaluated many varieties of potatoes in on-farm trials, adopted uniform spacing and deep cultivation, tested green manures (especially lupins) and animal manures, and experimented with variations in seed size. Some 2000 farmers have improved potato production from about 4000 k/ha to 10-15,000 kg/ha.

An example of the ways this project has broken away from the norms of agricultural practices centres on the adoption of lupins into crop rotations. The spread of *mucuna* (velvetbean) in central America, and its extraordinary effect on maize yields, prompted World Neighbors to send 13 farmer promoters from Bolivia and Peru to Honduras. *Mucuna* does not grow above elevation of 2800 masl, and would have been destroyed by the

process of mounding of soil around potatoes towards harvest. But lupin was identified by Milton Flores as an alternative – it can fix 200 kg N / ha / year, and benefits soils when turned under as a green manure. Farmers were at first incredulous, but their long association with the benefits of experimentation persuaded them to test the practice. Potato yields immediately increased from 1780 kg / ha to 8500 kg / ha with lupins, and rose to 13,000 kg / ha when sheep manure was also incorporated. The cash outlay for lupins is $18 / ha, which compares with the $170 / ha for an equivalent amount of inorganic fertilizer.

The project has seen many social benefits, not least improved household food security and health. Once yields improved, many farmers actually reduced their field size, sometimes by as much as 90%, so as to focus their intense efforts. Reduced field size turned out to have great benefits for women – making it easier for them to continue to farm whilst men migrate to cities in search of work

Source: Ed Ruddell, Ruddell et al, 1999

3. Brazil: Microbacias (watersheds) and zero-tillage (ZT) programme in Santa Caterina

The state government extension and research service, EPAGRI (Empresa de Pesquisa Agropecuária e Difusâo de Technologia de Santa Catarina), works with farmers in the southern Brazilian State of Santa Catarina, from the flat coastal areas in the east to the rolling highlands and mountains of the centre and west. It is involved in working at a microwatershed level with local farmers to develop low-input and productive systems of agriculture. Each member of staff works in about four microwatersheds of about 150 families for a period of two years, playing an important social as well as technical role. Farmer experimentation is encouraged, and there is a large amount of decision-making at the level of these local extensionists.

The technological focus is on soil and water conservation at the microwatershed level using contour grass barriers, contour ploughing and green manures. Farmers use some inorganic fertilizers and herbicides, but there has been particular success with green manures and cover crops. Some 60 species have been tested with farmers, including both leguminous plants such as velvetbean, jackbean, lablab, cowpeas, many vetches and crotalarias, and non-legumes such as oats and turnips. For farmers, these involve no cash costs, except for the purchase of seed. These are intercropped or planted during fallow periods, and are used in cropping systems with maize, onions, cassava, wheat, grapes, tomatoes, soybeans, tobacco and orchards. Farmers use animal-drawn tools to knock over and cut up the green manure / cover crop, leaving it on the surface. With another farmer-designed, animal-drawn instrument, they then clear a narrow furrow in the resulting mulch into which the next crop is planted. As a result, most farmers no longer plough.

The adoption of ZT in Santa Caterina is significant because farm structure is considerably smaller than in the neighbouring states of Paraná and Rio Grande do Sol (where hectarage under ZT has too seen extraordinary growth in the past decade). It is estimated that some 106,000 farmers have adopted ZT on about 880,000 hectares through the microbacias programme. There have been substantial improvements in yields: maize up 47% over eight years (to 1999) to reach 3750 kg / ha, soya up 83%to 2730 kg / ha, and wheat up 82% to 2125 kg / ha.

Like other ZT programmes, EPAGRI has documented improvements to water quality, soil health and water retention. Soils are darker in colour, spongy to the step, moist and full of earthworms. The reduced need for most weeding and ploughing has meant great labour savings for small farmers. From this work, it has become clear that maintaining soil cover is more important in preventing erosion than terraces or conservation barriers. It is also considerably cheaper for farmers to sustain.

A highly significant component of the microbacias programme has seen the transformation of whole watersheds and the attention to social capital formation. In Santa Caterina, some 7700 groups have been formed in 559 microbacias, and these have become engaged in a wide range of activities. EPAGRI has also worked to involve local municipalities fully in the process of participatory technology development and extension, and now many municipalities employ their own agronomists to help in the process.

Sources: Rubens Altman, Alicides José Molinari, Hercilio de Freitas, Airton Spires, John Landers, Francis Shaxson; de Freitas, 1999; Landers, 1999

4. Brazil: Zero-Tillage in large scale farms in Paraná and Rio Grande de Sol

Zero- or No-Till (*plantio direto*) has seen extraordinary spread amongst some 200,000 farmers in the two southern states of Paraná and Rio Grande de Sol. These have been organised into 2100 microbacias in Paraná, and 455 in Rio Grande do Sol. The total area under ZT in 1999 was 10.5 million hectares – up from about 700,000 ha in 1990. These farmers are organised into some 8000 Friends of Land Clubs, which are organised at many different levels – local, municipal, multi-municipal, river basin and state.

The model of ZT is unlike that adopted in industrialised countries, particularly in the USA, as green manures, cover crops and legumes have been incorporated into rotations, so reducing the system's requirement for herbicides for weed control. The major on-farm impacts have been on crop yields, soil quality and moisture retention, and labour demand, and reduced fossil fuel use (a 40-70% drop). Maize yields have improved by 67% from 3 to 5 t / ha in a decade, and soya by 68% from 2.8 to 4.7 t / ha. A great deal of recent interest has focused on the substantial public benefit being produced by these farms through sequestration of carbon in organic matter in soils. This new carbon sink is helping to mitigate the drivers of climate change.

The key conceptual change in these ZT programmes has been the transition from soil conservation thinking (based on physical conservation measures) to soil restoration and improvement (based on biological measures). Maintaining soil cover is much more important than preventing erosion through terraces or barriers. It is this that has led to benefits both for farmers and the wider environment. And as John Landers (1999) has put it: *"ZT has been a major factor in changing the top-down nature of crop services to farmers towards a participatory on-farm approach"*.

Sources: Maury Sade, Alicides José Molinari, Simon Hocombe, Francis Shaxson, John Landers, Christian Pieri; Lander, 1999

5. Brazil: Agroecological farming systems in Zona da Mata

This project works with about 200 farmers near a designated conservation area. A buffer zone incorporating five municipalities around the park has encouraged farmers to be aware of the local and national value of the resources. Through the use of a series of participatory methods, farmers have redesigned diverse farm systems to make the most of agro-ecological relationships for coffee cultivation, particularly centred on green manures, soil conservation and agroforestry practices. Five farmers unions have been incorporated into a regional association, and these focus on adding value through the processing of coffee beans, and direct sales to the market. These groups have also helped to improve annual fodder supplies to individual farmers.

Source: Anôr Fiorini

6. Colombia: Comité de Investigación Agrícola Local (CIAL) – in Colombia and seven other countries of Latin America

Many Latin American countries have reduced investments in agricultural research and extension, and so it is increasingly critical that research is decentralised and devolved to farmers themselves. The CIALs (or local agricultural research committees) are social and institutional mechanisms promoted by CIAT to develop and expand participatory and adaptive approaches to agricultural research, and to fill the gap left by the retreating state. Some 249 CIALs have been formed in eight countries: in Colombia, the CIAL programme has worked with 4000 farmers in about 50 communities. The aim is to improve agroecosystem productivity and health, extend the capacity of poor communities to solve agricultural problems, and take advantage of new economic opportunities.

All CIALs develop their own research topics, and so there is no common impact. The social learning and institutional process is, however, similar. CIALs incorporate four or more farmer researchers elected by their community to conduct experiments for the benefit of the all local farmers. Technical supervision is given by external technicians and agricultural scientists. Regional groupings of CIALs hold annual meetings to share findings, and increase cross-community interaction. As CIALs mature, so does the generalised social capital in communities at large. Many CIALs invest in wider community activities, such as basic milling equipment, or in rotating credit funds. There have been many improvements to yields – maize typically up from 820 kg / ha to 1400 kg / ha following adoption of agroecological approaches.

In communities with CIALs, some 30% of households suffer food shortages during August-September, whereas 50-65% are insecure in communities without CIALs. The greatest benefits appear to be for the poorest households. A wide range of different technologies have been developed, including rearing of guinea pigs, reintroduction of wheat cultivation, live barriers, IPM in potatoes, organically-produced sugar patties, agroforestry, use of green manures, mulches, and the establishment of small food enterprises. There are many important challenges, not least in finding ways to ensure that groups are able to mature and develop, rather than fall away after initial successes.

Source: Ann Braun; Braun, 2000

7. Cuba: national policy for sustainable agriculture

One of the most remarkable coordinated policy efforts on sustainable agriculture has occurred in Cuba. Up to 1990, Cuba's agricultural and food sector was heavily dependent on external support from the soviet bloc. It imported 100% of wheat, 90% of beans, 57% of all calories consumed, 94% of fertilizer, 82% of pesticides and 97% of animal feed. It was also paid three times the world price for its sugar. At this time, Cuba also had the most scientists per head of population in Latin America, the most tractors per hectare, the second highest grain yields, the greatest increase in per capita food production in the 1980s, the lowest infant mortality, the highest number of doctors per head population, the highest secondary school enrolment and lowest teacher: pupil ratios.

But in 1990, trade with the soviet bloc collapsed, leading to severe shortages in all imported goods. Within two years, petroleum imports fell to half of the pre-1990 level, fertilizers to a quarter, pesticides to a third, and food imports to less than half. The government response was to declare an "Alternative Model" as the official policy – an agriculture that focuses on resource-conserving technologies that substitute local knowledge, skills and resources for the imported inputs. It also emphasises the diversification of agriculture; the breeding of oxen to replace tractors; the use of IPM to replace pesticides; the introduction of new practices in science; the need for widespread training; the promotion of better cooperation among farmers both within and between communities; and reversal of the rural exodus by encouraging people to remain in rural areas.

The impact of the new policy has already been remarkable. Some 220 village-based and artisanal Centres for the Reproduction of Entomophages and Entomopathogens have been established for biopesticide manufacture. They produce 1300 t / year of *Bacillus thuriengiensis* sprays (used to control lepidoptera), 780 t / year of *Beaveria* sprays (for controlling beetles), 200 tonnes of *Verticillium* (for whitefly control) and 2800 tonnes of Trichoderma (a natural enemy). Many biological control methods are proving more efficient than pesticides. The use of cut banana stems baited with honey to attract ants, which are then placed in sweet potato fields, has controlled sweet potato weevil. There are 173 vermicompost centres, the annual production of which grew from 3000 to 93,000 tonnes. Crop rotations, green manuring, intercropping and soil conservation have all been incorporated into polyculture farming: cassava-beans-maize, cassava-tomato-maize, and sweet potato-maize have all been shown to be 1.5-2.8 times more productive than the sum of the individual monocultures.

Two important strands to sustainable agriculture in Cuba have emerged:

i. intensive organic gardens in urban areas of three types – self-provisioning gardens in schools and

workplaces (*autoconsumos*), raised container-bed gardens (*organoponicos*), and intensive community gardens (*huertos intensivos*);

ii. sustainable agriculture on both large and small farms in rural areas.

Both have made a significant contribution to total food production (urban areas are defined as all farming within municipal boundaries and all agriculture within 3 km of population centres above 2000 people). In 1994, for example, *organoponicos*, *autoconsumos* and *huertos intensivos* were producing some 4200 tonnes of food per year. By 1999, this had grown to 727,000 tonnes. Both the number of gardens and per area productivity has increased. There are now some 7080 gardens (up from 2500 in 1997), and productivity has grown from 1.6 kg / m^2 (1994) to 19.6 kg / m^2. It is difficult to say how many farms are now devoted to sustainable agriculture practices – estimates suggest some 200,000 farms on about 150,000 hectares. For the *organoponicos*, an estimated 26,000 people are involved in direct food production.

One measure of effectiveness of sustainable agriculture to produce the necessary food is the aggregate data on calorific intake. This was 2600 kcal / day in 1990, fell to some 1000-1500 / day soon after the transition (with severe food insecurity), and has risen to an average of 2700 kcal / day by the end of the 1990s.

At the forefront of the transition towards sustainable agriculture has been the Grupo de Agricultura Organica (formerly known as the Asociación Cubanes Agricultural Organica, and formed in 1993). GAO beings together farmers, field managers, field experts, researchers and government officials to help convince farmers that organic-based alternatives can produce sufficient food for Cubans. There remain many difficulties though: i) proving the success of an alternative system to sceptical farmers, scientists and policy-makers; ii) developing new technologies sufficiently quickly to meet emerging problems; iii) coordinating the many actors to work together; iv) the need for continued decentralisation of food production to farmer level, and the appropriate land reform to encourage local investment in natural asset-building; v) encouraging farmers of large scale rice, potato, sugar cane and citrus to reduce their use of pesticides and fertilizers.

Sources: Rosset, 1997, 1998; Murphy, 1999 Sources: Rosset, 1997, 1998; Murphy, 1999

8. Dominican Republic: Plan Sierra soil conservation

The Plan Sierra ecodevelopment project took on the challenge of breaking the link between rural poverty and environmental degradation in the central cordillera of the Dominican Republic. The strategy consisted of developing alternative production systems for the highly erosive systems used by local farmers. Controlling erosion in the Sierra is not only important for the betterment of the life of these farmers but also represents hydroelectric potential as well as an additional 50,000 hectares of irrigated land in the downstream Cibao valley.

The main goal of Plan Sierra was the development and diffusion of production systems that provided sustainable yields without degrading the soil thus ensuring the farmers' productivity and food self-sufficiency. More specifically, the objectives were to allow farmers to more efficiently use local resources such as soil moisture and nutrients, crop and animal residue, natural vegetation, genetic diversity, and family labour. In this way it would be possible to satisfy basic family needs for food, firewood, construction materials, medicinals, and income. A range of farming methods are integrated in several ways: i) soil conservation practices such as terracing, minimum tillage, alley cropping, living barriers, and mulching; ii) use of leguminous trees and shrubs planted in alleys, for nitrogen fixation, biomass production, green manure, forage production, and sediment capture; iii) use of organic fertilizers based on the optimal use of plant and animal residues; iv) adequate combinations of polycultures and / or rotations planted in contour and optimal crop densities and planting dates; v) conservation and storage of water through mulching and water harvesting techniques. Animals, crops, trees, and / or shrubs are integrated to result in multiple benefits such as soil protection, diversified food production, firewood, improved soil fertility, and so on. More than 2000 farmers have adopted some of the improved practices.

Source: Miguel Altieri

9. Honduras, Guatemala and Nicaragua: Hillside improvement

Some 45,000 farm-families in Honduras and Guatemala have benefited from the adoption of sustainable agriculture, increasing crop yields from 400-600 kg / ha to 2000-2500 kg / ha. Farmers use green manures, cover crops, contour grass strips, in-row tillage, rock bunds and animal manures, which are finely-tuned through experimentation to local conditions. These programmes have regenerated local economies. Land prices and labour rates are higher inside the project areas, and families have moved back from capital cities. There are also benefits to the forests. Farmers say they no longer need to cut the forests, as they have the technologies to farm permanently the same piece of land. Throughout Central America, various NGOs have promoted the use of grain legumes, especially velvet bean *(Mucuna pruriens)* to be used as green manure, an inexpensive source of organic fertilizer to build up organic matter. Taking advantage of well established farmer-to-farmer networks, eg *campesino a campesino* movement in Nicaragua and elsewhere, the spread of this simple technology has occurred rapidly.

Source: Roland Bunch, Bunch 2000

10. Mexico: ISMAM fair-trade coffee

One example of an initiative that began at the local level and has received national recognition is one from Mexico. Indígenas de la Sierra Madre de Motozintla (ISMAM) is a Maya Indian Organic Coffee group in Chiapas. ISMAM was formed by smallholder coffee growers to meet problems of low productivity, poor marketing conditions and extreme poverty of farm families. By adopting organic techniques and improving quality, the coop was able to overcome soil degradation and low yields and move into a privileged speciality market that rewarded their extra efforts towards an ecologically sound production. Through sound,

participatory management of the organisation and hard work, ISMAM was able to capitalise their enterprise, overcome initial government disinterest and repression to become a major agro-industry with their own processing facilities and direct export markets in the US, Europe and Japan.

They have begun to produce blends and soluble coffee for the national market and to diversify their agro-production for greater food security. Besides expanding their business, part of ISMAM's profits are returned to regional committees of the coop for investment in social works. In 1995 ISMAM received the National Agro-Export prize from the hands of Mexico's President. They now enjoy a privileged position with respect to credit and government support and have diversified their business into a number of areas including eco-tourism.

Source: Ronald Nigh

11. Mexico: UCIRI fair-trade and organic coffee

The Union of Indian Communities in the Isthmus Region was organised by farmers in Oaxaca for the cultivation and marketing of organic coffee. This was partly to reduce dependency on credit, but also to improve yields. Organic coffee cultivation demands more active management and a higher labour input from farmers. Coffee is planted on the contour to stop soil erosion, and slashed weeds and pruned branches are also laid on the contour. Half-moon terraces are constructed for each coffee tree. Formerly the coffee beans were depulped into waterways, causing significant water pollution - now farmers return the pulp to the fields after composting, along with animal manures, lime and green plant material. This improved system produces 600-1200 kg / ha of coffee beans, an improvement of 30-50% compared with earlier practices. The Union has 4800 members, and has been able to build up its own infrastructure for the transport, storage, processing, and export of coffee. The premium received for the organic coffee from fair trade organisations is used for a range of social purposes, especially improving schools. The Union also runs public transport and medical insurance systems, and owns several shops.

AFRICA

1. Benin: Mucuna (velvetbean) cover cropping

This is an example of the introduction of a simple regenerative component into farm systems combined with increasing farmers' capacity for local-adaptation of the technology. The spread of mucuna (*Mucuna pruriens*) for suppression of the aggressive weed imperata (*Imperata cylindrica*) has occurred because of land scarcity, decline in soil fertility, lack of fertilizer, and weed encroachment. Soils on the plateaux of southern Benin and Togo are nearing exhaustion. Fertilizer use is low among the large class of smallholder farmers. But even if fertilizers were available, the benefit from their use is declining because of a degrading soil resource base. Another consequence of the reduced fallow periods is encroachment of imperata, an aggressive weed that is very difficult to eradicate by hand. Researchers with the Recherche Appliquee en Milieu Reel project introduced mucuna cover cropping to alleviate the constraint of low nutrient supply to maize, the staple crop.

The government extension services (Centre d'Action Regional pour le Developpement Rural - CARDER) became interested in this success and started testing the system. In 1990, the CARDER for Mono Province tested the system in 12 villages with 180 farmers. They expanded to other southern provinces in 1991 and the number of farmers testing mucuna grew to approximately 500. Large NGOs became involved and some 14,000 farmers now growing mucuna throughout Benin.

Farmers who adopted mucuna cover cropping benefited from higher yields of maize with less labour input for weeding: maize following mucuna yields 3-4 t / ha without application of nitrogen fertilizer (similar to yields normally obtained with recommended levels of fertilization at 130 kg N / ha); whilst yields on plots previously planted with maize and cowpea was 1.3 t / ha. Mucuna as an intercrop or as a sole crop provides more than 100 kg N / ha to the following maize.

The benefit:cost analysis over a period of 8 years indicated a ratio of 1.24 when mucuna was included in the system, and 0.62 for the system without mucuna. The ratio was as high as 3.56 if mucuna seeds were sold. However, yearly analysis of the benefit: cost ratio indicated a declining trend over time for all systems suggesting that addition of external inputs (probably P and K fertilizer) are required in order to achieve full sustainability. Adoption of mucuna throughout the Mono Province would result in savings of about 6.5 million kg of nitrogen or about US $1.85 million / year.

Source: Bob Carsky, Victor Manyong

2. Burkina Faso: Soil and Water Conservation

Abandoned and degraded lands in dryland Burkina Faso have been improved with the adoption of tassas and zaï: 20-30 cm holes dug in soils that have been sealed by a thin surface layer hardened by wind and water action. The holes are filled with manure, which improve organic matter, promotes termite activity, and enhances infiltration. When it rains, the holes fill with water and millet or sorghum is planted. Tassas are normally used in conjunction with stone bunds.

In Burkina Faso, some 100,000 hectares have been restored – each producing some 700-1000 kg of cereal per year. Yields of millet without tassas, demi-lunes and contour stone bunds are 150-300 kg / ha; they rise to 400 kg with manure in a poor rainfall year, and 700-1000 kg / ha in a good rain year. Reij (1996) indicates that the average family in Burkina Faso using these technologies have shifted from being in annual cereal deficit amounting to 644 kg (equivalent to 6.5 months of food shortage) to producing a surplus of 153 kg per year. Tassas are best

suited to landholdings where family labour is available, or where farm hands can be hired. The technique has spawned a network of young day labourers who have mastered this technique and, rather than migrating, they go from village to village to satisfy farmers' growing demands.

Source: Alberta Mascaretti, Chris Reij

3. Ethiopia: Cheha Integrated Rural Development Project

This is an example of an integrated and relatively small-scale project making a substantial impact on regional food security. It has been working in south-west Ethiopia since the drought of 1984, and has introduced of new varieties of crops (vegetables) and trees (fruit and forest), promoted organic manures for soil fertility and botanicals for pest control, and introduced veterinary services. Some 12,500 farm households have adopted sustainable agriculture on about 5000 ha, resulting in a 70% improvement of overall nutrition levels within the project area, along with a 60% increase in crop yields. Some farmers have begun to produce excess crops which they sell in local markets, earning much needed income for their families. Thus an area once reliant entirely on emergency food aid has now become able to feed itself and have enough left over to contribute to surplus. The real promise of the programme, however, lies in the fact that farmers are replicating activities on their own initiative (including those outside the project area), where once they had to be encouraged to participate through food for work payments.

Source: Food for the Hungry International

4. Kenya: Association for Better Land Husbandry

Effect of double-dry beds on maize (left) and vegetables (right),
Association for Better Land Husbandry, Kenya

The ABLH is supported by the UK Department for International Development and promotes business development through low cost methods of conservation-based farming that reduce poverty, improve rural people's livelihoods and boost rural economies. It works on the premise that systems of sustainable and productive land use can be developed largely with the existing skills, knowledge and social organisation of rural people. It facilitates the formation of self-help groups of farmers, promotes sustainable agriculture technologies to these groups, helps them to market the outputs, and helping them to find ways to process and pack produce so as to retain greater added-value. It is engaged in business development, supporting community factories, and developing certification schemes and farmers' own brands to give produce better returns in local and national markets.

The approach to sustainable agriculture is called `near nil investment'. The basic principle is that poor rural families do not have the financial resources to invest in farm improvements. What they need are ways to boost productivity and income by making the best use of available human and natural resources. The technologies proven to work are concerned with the regeneration and recycling or organic matter for soil management, and the use of natural pesticides such as neem. The aim is to find ways to maximise returns from these technologies, and then `top-up' with externally-sourced fertilizers and pesticides where necessary and safe. Other low-investment resource-conserving technologies and practices are also made available to farmers, including beekeeping and agro-forestry. Most activities are currently focused on homegardens, though progress is also being made with field crops such as soya and sunflower.

Double dug beds combined with composting, green and animal manures improve the soil. A considerable investment in labour is required, but the better water holding capacity and higher organic matter means that these beds are more productive, more diverse and are able to sustain vegetable growth long into the dry season. Once this investment is made, little more has to be done for the next 4 to 6 seasons (2-3 years). Many vegetable and fruit crops are cultivated, including sukumawiki and other kales, onions, tomatoes, cabbage, passion fruit, pigeon peas, spinach, peppers, green beans and soya.

Self-help groups have found that their family food security has improved substantially since adopting conservation farming. Before, they had to use cash when they were short of food in the dry season to pay for maize and vegetables. They had to sell their labour, rely on remittances from family members working elsewhere in the country, or sell cash crops. They would have to do this at a time when food prices were high and labour and cash crop prices low. Many also relied on collecting wild foods from forests. But now, families have found that by working more on their own farms rather than selling labour to others, they are getting greater returns. They have found that investment on their own farms in natural capital pays better returns in food production. Casual hiring out of labour has virtually disappeared among SHG members. Children have been beneficiaries, as their health has improved through increased vegetable consumption and longer periods of available food. According to one review of 26 communities in eight Districts, 75% of households are now free from hunger during the year, and the proportion of households buying vegetables has fallen from 85% to 11%.

Source: Jim Cheatle, Jules Pretty; Pretty, 1997, 2000

5. Kenya: Community mobilisation against desertification (C-MAD) programme

The C-MAD programme works in a `low-potential' part of South Nyanza, western Kenya. The programme area has a single rainfall season, and the land is badly degraded due to overgrazing and deforestation. The project

began as a straightforward tree-planting effort, expanded to incorporate soil conservation, soil fertility and organic farming methods, and now focuses on whole farm improvements. The social processes incorporate participatory learning methods, farmer-based research groups, strengthening community and village groups, and collaboration with government and non-government research and extension agencies.

It works with about 500 farmers in some 1000 hectares, who have seen maize yields improve from about 2 to 4 t/ha. Income has also increased for many farmers following the cultivation of fruit (citrus, orange, mango, pineapple). The project reports increased local employment through growth in demand for on-farm labour. The cultivation of vegetables in home gardens has further improved domestic food security. The project also reports reduced child mortality and improved health and nutritional status.

Source: Peter Omondi, C-MAD

6. Kenya: *Vutu-sukumu* (Push-pull) pest management in smallholder systems

The work of ICIPE is explicitly focused on designing low-cost integrated pest management technology. It works closely with farmers to test and adapt technologies. It is also producing unexpected synergistic effects through manipulation of agricultural systems and the paradigms that define them. ICIPE approaches sustainable plant pest management on four major fronts:

- biological control, using one organism to control another;
- botanical agents, natural pest control compounds that are derived from plants;
- habitat management, manipulating the cultivated and natural environment to preserve the pest-natural enemy balance and richness of species;
- pest-tolerant varieties of major food crops that deter insect damage.

One activity is investigating novel habitat management approaches to suppress cereal stem borer and *Striga* populations in maize and sorghum. This project is developing novel 'push-pull' strategies to repel stem borers from the cereal crop and attract them to intercrop or barrier forage grasses. It has found extra-ordinary multi-functionality in a range of fodder grasses and legumes in cereal systems.

The strategy involves trapping pests on highly susceptible trap plants (pull) and driving them away from the crop using a repellent intercrop (push):

1. The forage grasses, *Pennisetum purpureum* (Napier grass) and *Sorghum vulgare sudanense* (Sudan grass), attract greater oviposition by stem borers than cultivated maize.
2. Non-host forage plants, *Melinis minutiflora* (molasses grass) and *Desmodium uncinatum* (silver leaf) repel female stalk borers (*Chilo spp).*
3. Intercropping with molasses grass (*Melinis minutiflora*) increases parasitism, particularly by the larval parasitoid, *Cotesia sesamiae*, and the pupal parasitoid *Dentichasmis busseolae. Melinis* contains several physiologically active compounds. Two of these inhibit oviposition (egg laying) in *Chilo*, even at low concentrations.
4. Molasses grass also emits a chemical, (*E*)-4,8-dimethyl-1,3,7-nonatriene, which summons the borers' natural enemies.
5. Napier grass also has its own defence mechanism against crop borers: when the larvae enter the stem, the plant produces a gum-like substance kills the pest.
6. Sudan grass also increases the efficiency of the natural enemies (the parasitism rate on larvae of the spotted stemborer, *Chilo partellus* more than tripled, from 4.8% to 18.9% when the grass was planted around maize in a field and from 0.5% to 6.2% on *Busseola fusca*, another important pest).
7. ICIPE has found that intercropping maize with the fodder legumes *Desmodium uncinatum* (silver leaf) and *D. intortum* (green leaf) reduced infestation of parasitic weed, *Striga hermonthica* by a factor of 40 compared to maize monocrop. Reduction in S*triga* infestation by intercropping maize with the two species of *Desmodium* was significantly more than intercropping maize with soybean, sun hemp and cowpea.

Researchers from ICIPE and IACR-Rothamsted have found that such 'push-pull', using the attractive plants as trap crops and repellent plants as intercrops, reduces stem borer attack and increases levels of parasitism of borers on protected maize, resulting in a significant increase in yield. Farmer participatory trials in 1997 and 1998 have shown significant yield increases in maize. The aim is now to develop a maize-based cropping system that will reduce yield losses due to both stem borer and *Striga* and at the same time improve soil fertility due to nitrogen-fixing action of *Desmodium*. Such a redesigned and diverse system has many of the characteristics of `traditional' farms in Kenya.

Further ICIPE research is showing the effectiveness of neem to control weevils in bananas, diamondback moth in brassicas, and fruitborers in tomatoes; is developing resistant cultivars

based on traditional germplasm; is showing the value of sterile male release for fruit fly control; and is demonstrating control of the stemborer, *Chilo partellus*, through identification of a natural enemy from Pakistan, the parasitic wasp *Cotesia flavipes* (Chilo was accidentally introduced from Asia in the 1930s, and has no co-evolved local natural enemies), which has now been released in Kenya, Mozambique, Uganda, Zambia and Somalia.

Sources: Hans Herren, John Pickett, ICIPE annual reports; Pickett, 1999; Khan et al, 2000

7. Kenya: Ministry of Agriculture soil and water conservation

Kenya has a long history of state intervention in both soil and water conservation and land management. Early approaches focused on providing cash payments to encourage farmers to construct the labour-intensive measures such as cut-off drains and artificial waterways. But by the end of the 1980s, it had become clear that the conventional approach to soil and water conservation was unable to meet the prevailing environmental challenge.

The Government of Kenya recognised that the only way to achieve widespread conservation coverage was to mobilise people to embrace soil and water conserving practices on their own terms. All financial subsidies were stopped, and resources allocated instead to participatory processes, extension, training, tools and farmer trips. It adopted in 1989 the Catchment (or Area of Concentration) Approach. This is seen as a way of concentrating resources and efforts within a specified catchment (typically 200-500 hectares) for a limited period of time (generally one year), during which all farms are laid out and conserved with full community participation. Small adjustments and maintenance would then carried out by the community members themselves with the support of local extension agents.

Participatory methods imply shifts of initiative, responsibility and action to rural people themselves. Interdisciplinary teams drawn from various government departments work for about a week in the catchment. These teams often include officers from MALDM, as well as those from other departments and ministries, including Education, Environment, Fisheries, Forestry, Public Works, Water Development, and Health. They sometimes include staff of local and international NGOs who are actively working in the catchment. Following the Rapid Catchment Analysis phase, a Catchment Conservation Committee of farmers is elected as the institution responsible for co-ordinating local activities. A Catchment Report is prepared, which serves as a baseline document for planning, implementation, monitoring and evaluation, and for co-ordinated action by extension professionals based at Divisional and District level.

The Catchment Approach brings significant benefits over the individual farmer approach. The number of farms fully conserved each year in Kenya with various SWC measures has risen with the Catchment Approach from 59,450 (with doubts about sustainability) in 1988 to some 100,000 in the mid-1990s.

The process of implementation of the Catchment Approach itself has varied according to the human resources available and differing interpretations of the degree of participation necessary to mobilize the catchment community (Pretty et al, 1995). The impacts vary according to the quality of the interaction between extension staff and local people. When participation in planning and implementation is interactive, the impacts are substantially greater than when participation is simply consultative.

In an interactively planned catchment, an interdepartmental participatory rural appraisal is conducted to launch the catchment, which includes a *baraza* for presenting back findings and developing joint plans. The catchment committee is freely elected, and includes both men and women. After the catchment has been completed, the committees tend to remain active and committed to maintenance and replication. In conventionally planned catchments, the *baraza* is held mainly for publicity purposes, the catchment committees are more frequently selected by local leaders, and women rarely participate. The committees tend to become inactive soon after intensive contact with extension staff ends.

Sources: J K Kiara, Jules Pretty pers. observation, MoA/MoALDM annual reports 1989-1999; Pretty et al, 1995

8. Kenya: Mumias Education for Empowerment Project

The MEFE project works with some 2070 households in Kakamega, and area of western Kenya characterised by high rates of rural malnutrition, infant mortality and non-literacy. Severe food insecurity affected 1 in 4 people before the project, with many households only food secure for

1-3 months per year.

The project uses a structured learning process (REFLECT) to encourage all groups to analyse critically their own environment and to seek new solutions based on locally-available resources. The project uses a range of integrated pest management methods together with legumes, cover crops and green manures for soil fertility improvement. Raised beds have been incorporated on farms to increase vegetable production. As a result, beans and groundnut yields have doubled from 300 to 600 kg / ha. The project reports that the food security period has improved to 3-6 months for a typical household. The increased consumption of protein particularly benefits child health.

Source: Francisca Mate, James Atema

9. Kenya: Adaptive research programme, Environmental Action Team (EAT)

The EAT is a small on-farm research project based in Kitale in western Kenya, working with 130 farmers on about 80 hectares. In this area of Trans-Nzoia, food insecurity is widespread amongst small-holders. Farmers typically plant whole 0.5-1 hectare farms with maize, usually intercropped with beans. They use late maturing hybrids, which remain in the ground for 8-9 months. But due to low soil fertility, and farmers' inability to purchase fertilizers, yields are only 650-1750 kg / ha. The yields of the main source of household protein, beans, are also very low, mainly die to pests and diseases (especially root rot and bean fly) and low soil fertility. This leads to protein malnutrition amongst poorest households.

EAT seeks to address these problems through participatory research and training. Farmers are trained in the principles and practice of biological agriculture, with a particular focus on soil health. New technologies are tested on farm, adapted, and then spread by farmers to neighbours if they work. The project helps farmers form groups –mostly it is women who come together first, and men who are attracted once the dramatic changes in productivity have been achieved.

A variety of technologies and practices have been adopted to improve household food production. These include: i) legumes and green manures - eg relay cropping of lablab into maize after 120-140 days – the legume takes over the land during the dry season, and the legume and maize residues are incorporated into the soil after harvest; and ii) composts and farmyard manure, with or without diammonium phosphate fertilizers, Tithonia and Sesbania. As a result, maize yields have improved to 3300-5500 kg / ha, and bean yields 4-8 fold. Further research is focusing on the trade-offs of harvesting legume grain and / or leaves compared with retaining all the green manure residues for the soil. EAT also promotes crop diversification with finger millet, soyabean, groundnut, pigeon pea and Irish potatoes, as well training farmers in intensive organic vegetable production in raised beds in home gardens.

Source: Beth Kirungu, Joseph Mureithi

10. Lesotho: Machobane Farming System

The Machobane Farming System is an example of a fundamentally redesigned system yielding multi-functional benefits. Lesotho is severely affected by erosion and land degradation. During the last twenty years, arable land fell 14 to 9% of the country's total area, and crop yields are now about half the 1970s level. Dr. J.J.Machobane, a Mosotho agronomist, first conceived his system over 40 years ago, experimenting on his own land for 13 years before attempting to launch it amongst fellow farmers. Unlike most extension methods, the Machobane approach starts with the basic behavioural requirements for adopting its technical message:

- self-reliance - farmers must be convinced that they can achieve food security without external assistance;
- appreciation of the resource base - farmers must be ready to work hard, and be convinced that they can improve crop production by fully exploiting their resource base;
- learning and teaching by doing - farmers must be trained on their own fields and farmer trainers must be ready to do work along with them;
- spontaneous technology spreading - farmers learn from other farmers, and Machobane farmers have the duty to help their neighbours.

In Lesotho mountain areas, most crops are grown on terraced land, but poor soil structure, inadequate soil fertility management and erratic rainfall, mean that land productivity is low and variable. According to Machobane, these constraints can be overcome by rational exploitation of the resource base and minimising the need for purchased inputs. The technical elements include intercropping, localised placement of ash (from household waste) and manure, weeding,

introduction of potato as a cash crop, preservation of natural enemies, row-rotations, and legumes with cereals.

Farmers adopting the MFS indicate three advantages of the system: (i) higher land productivity (0.4 ha per family needed for food security compared with the more normal 1.2 ha); (ii) large cash income obtained by planting potato; and (iii) better resistance to drought: their fields are green compared to non-Machobane fields during drought. In addition, MFS will substantially reduce farm income fluctuations through the combination of lowering yield fluctuations of individual crops, spreading risk of fluctuations in yields and prices by planting a larger range of crops and decreased reliance on imported inputs (fertilizers and pesticides). Some 2000 farmers are now practising this system.

Source: Alberta Mascaretti

11. Madagascar: System of rice intensification (SRI)

The System of Rice Intensification (SRI) was first developed in Madagascar by Fr. Henri de Laudanié in the 1980s, has been promoted since 1990 by the Association Tefy Saina, and evaluated by the Cornell International Institute for Food, Agriculture and Development. The system has improved rice yields from some 2 t/ha to 5, 10 or even 15 t/ha on farmers' fields. This has been achieved without having to use purchased inputs of pesticides or fertilizers. The SRI is centred on making best use of the existing genetic potential of rice by breaking many of the conventional `rules' of management:

i. Rice seedlings are usually transplanted at about 30 days (sometimes as late as 40-50). In the SRI, seedlings are transplanted at 8-12 days. This increases tillering – with SRI plants typically having 50-80 tillers compared with 5-20 for conventional ones.
ii. Rice seedlings are usually planted close together to minimise weed infestation. But in the SRI, they are planted at least 25 cm apart in a grid pattern rather than rows. This facilitates mechanical weeding, as well as reducing seed use from 100 kg/ha to about 7 kg/ha. Wider spaced plants develop a different architecture, with more room for roots and tillers. Better root systems means reduced lodging.
iii. Most scientists and farmers believe that rice, as an aquatic plant, grows best in standing water. In the SRI, however, paddies are kept unflooded during the period of vegetative growth. Water is only applied to keep the soil moist, which is allowed to dry out for periofds of 3-6 days. Only after flowering are paddies flooded, which are then drained 25 days before harvest (as for conventional rice). Such management encourages more root growth.
iv. Flooding is the conventional approach to weed control. With SRI, farmers must weed up to four times – mechanically or by hand. Farmers who do not weed still get respectable yield increases of 2-3 fold; but those that weed get increases of 4-6 fold.
v. SRI farmers use compost rather than inorganic fertilizers

The improvement in rice yields with SRI have been so extraordinary that, until lately, they have been simply ignored by scientists. SRI challenges so many of the basic principles of irrigated rice cultivation, and so many professionals have been entirely sceptical. But it is the number of farmers adopting SRI that is proof of its effectiveness and efficiency.

It is estimated that some 20,000 farmers have now adopted the full SRI in Madagascar (Tefy Saina estimates that 50-100,000 farmers are now experimenting with elements of the system). Cornell have helped research institutions in China, Indonesia, Philippines, Cambodia, Nepal, Cote d'Ivoire, Sri Lanka, Cuba, Sierra Leone and Bangladesh locally to test SRI. In all cases, rice yields increased several fold. In China, for example, yields of 9-10.5 t/ha were achieved in the first year (compared with a national average of 6t/ha).

Sources: Norman Uphoff; Uphoff, 2000a, b

12. Malawi: small scale aquaculture

The International Center for Living Aquatic Resources Management (ICLARM) works to integrate pond fish culture into low input farm systems in Malawi. The programme uses a participatory process for farmers and scientists jointly to map resource flows on farms, and then identify the potential for adjustments that would bring synergistic effects. It has worked with some 2000 individual farmers on both vegetable improvements in home gardens and fish-pond aquaculture. This integrated agriculture-aquaculture component of farmers often comprises only

500 m^2 within an average farm size of 1.5 hectares. Yet intensification of just this core component has led to significant improvements in food security – vegetable yields have grown to 2700 to 4000 kg / ha, and fish ponds produce the equivalent of 1500 kg / ha of fish – a new source of food for households. These integrated farms also produce six times more cash than conventional farms - with the vegetable-fish element contributing up to 70% of annual cash income.

ICLARM has documented the steady improvement of productivity in these systems amongst collaborating farmers – with pond productivity increasing steadily from 800 to 1500 kg / ha. Amongst those farmers trained only through the conventional Training and Visit system in southern Malawi, yields by contrast fall steadily, as the over-designed systems unravelled as farmers lost control. An asset-building approach, building both on natural capital on the farm and farmers own human capital (skills and knowledge) allows for continuous readjustments over time.

Source: Randall Brummet, Daniel Jama; Brummet, 2000

13. Malawi: Agroforestry Extension project (MAFE)

This participatory extension project work with some 20,000 farmers on 4200 hectares to encourage the adoption of various agroforestry practices within farms. These include i) undersowing of *Tephrosia vogelii*, pigeon pea and *Sesbania sesban* in maize for soil fertility improvement; ii) dispersed tree interplanting (eg *Faidherbia, Acacia polycantha. A. galpinii*); and iii) soil and water conservation practices, especially contour grass hedges.

The project uses participatory approaches to bring a wide range of government and non-government organisations together with farmers to ensure that these technologies are well-adapted to local conditions. Farmers are formed into farmer associations, which can then draw down on these external bodies for specific services. The project has trained farmer trainees, who pass on their expertise to colleagues. As a result of these social process and new technologies, maize yields have improved from 700 kg / ha to 1500-2000 kg / ha. Farmers have become less dependent on fertilizers (many of which are too expensive for smallholders), and the project reports more households becoming both food and woodfuel secure. Some 6.98 million trees were planted in 1999 by 1155,913 households, and the project expects to see reduced pressure on natural forests as these mature.

Source: Zwide Jere, MAFE project

14. Niger: Soil and water conservation

The IFAD-funded soil and water conservation in Illéla district is an example of a key sustainable agriculture technology having substantial multi-functional benefits whilst improving formerly degraded or abandoned lands. Some 5800 ha of abandoned and degraded lands on the farms of some 6000 households in 77 villages have been improved with the adoption of tassas (also known as zaï in Burkina Faso). Large-scale erosion control measures were not successful in the region.

Tassas are 20-30 cm holes dug in soils that have been sealed by a thin surface layer hardened by wind and water action. Since this crust prevents infiltration by water, these areas are usually abandoned, devoid of vegetation, scattered with outcroppings of iron crust, and are prime sites for surface erosion. The holes are filled with manure, since soils in this region are normally lacking in organic matter. This also helps to promote termite activity during the dry season, so further enhancing infiltration. When it rains, the holes fill with water and farmers then plant millet or sorghum. Tassas are normally used in conjunction with stone bunds, taking advantage of the stones that farmers remove from fields for planting. These methods of soil and water conservation were learned by farmers of Illéla on a visit to Yatenga in Burkina Faso where, on the central plateau alone, some 100,000 hectares have been restored – each now producing some 700-1000 kg of cereal per year. According to Hassan (1996), yields of millet without tassas, demi-lunes and contour stone bunds are of the order of 150-300 kg / ha. They rise to 400 kg with manure in a poor rainfall year, and 700-1000 kg / ha in a good rain year. Addition of some fertilizer increases yields again – to 650 kg / ha in poor years and 1400-1500 kg / ha in good ones.

This soil-development activity has allowed the region to attain average millet yields of 480 kg / ha, reaching levels of up to 700 kg / ha if chemical fertilizer is added (an as-yet uncommon practice). Comparatively, fields of similar quality levels produced only 130 kg / ha According to IFAD, food availability in participating households rose between 20% and 40%, depending on local rainfall conditions. Reij (1996) indicates that the average family in Burkina Faso and Niger

using these sustainable agriculture technologies have shifted from being in annual cereal deficit amounting to 644 kg (equivalent to 6.5 months of food shortage) to producing a surplus of 153 kg per year.

Tassas are best suited to landholdings where family labour is available, or where farm hands can be hired. The technique has spawned a network of young day labourers who have mastered this technique and, rather than migrating, they go from village to village to satisfy farmers' growing demands. There are cases of land being bought back by farmers who recognized early on the profit that can be earned from this land.

Three key factors have contributed to the development and dissemination of this technology in the farming community:

- An action-research approach that combines flexibility, openness to farmer initiatives, a forward-looking attitude and willingness to negotiate;
- A technology that combines the core benefits of innovation: immediate results, simplicity, ability to be integrated into existing cropping systems, and replicability
- A technological package that can adjust to the changing local context.

Sources: Alberta Mascaretti, FAO; Reij, 1996; Hassan, 1996

15. Senegal: Rodale Regenerative Agriculture Research Center

Effect of water harvesting in Senegal
(Pictures: Amadov Diop, Rodale Institute)

In Sahelian countries, the major constraints to food production are related to soils, most of which are sandy and low in organic matter. Where they are heavier and better in quality, they are subject to intensive use and so exposed to erosion by water and wind. In Senegal, soil erosion and degradation threaten large areas of agricultural land. Since 1987, the Rodale Institute Regenerative Agriculture Research Center has worked closely with farmers associations and government researchers to improve the quality of soils in Senegal by using agroecological methods.

Regenerative agriculture in the peanut basin has resulted in positive biophysical, environmental, social and economic benefits. The primary cropping system of the region is a millet-groundnut rotation. Fields are cleared by burning, and then cultivated with shallow tillage using animals. But fallow periods have decreased dramatically, and the use of inorganic fertilizers and pesticides is rare amongst smallholders, owing to high prices. It has also been well-established that inorganic fertilizers do not return expected yields unless there is concurrent improvements in organic matter – nutrients are washed away by the first rains, or are taken up by soil microbes and weeds. Soils low in organic matter also do not retain moisture well.

The RARC works with about 2000 farmers in 59 groups to improve the soil quality, integrate stall-fed livestock into crop systems, add legumes and green manures, improve the use of manures and rock phosphate, incorporate water harvesting systems, and develop effective composting systems. The result has been a 75-195% improvement in millet yields – from 330 to 600-1000 kg / ha, and in groundnut yields from 340 to 600-900 kg / ha. Yields are also less variable year on year, with consequent improvements in household food security. As Amadou Diop has put it: *"crop yields are ultimately uncoupled from annual rainfall amounts. Droughts, while having a negative effect on yields, do not result in total crop failure".*

Sources: Amadou Diop; Diop, 2000

16. Uganda: household livestock development

Heifer Project International introduced zero-grazing of dairy production to Uganda. This involves keeping good quality dairy cows in confinement and cut and carry feeding. The system includes production of forages, grasses and leguminous trees. Much of these are grown on bunds and intercropped with food or cash crops thus conserving soil and moisture. The system also results in greater food security and better family nutrition. Animals are a good source of income and food in the dry season and ruminants can use much to the crop and food processing by-products. The gathering of manure and compost from the zero-grazing unit, provides an ongoing source of organic fertiliser and provides for the rapid recycling of limited nutrients within the system. The strengthening of community groups which provide mutual support and training is another significant component.

Dairy heifers are provided as an in-kind loan. Farmers repay the loan by raising a female offspring which is then "passed on" to another farmer in the community. Thus the group has a capital resource which also for the benefit of the program to continue to spread. The zero-grazing system was introduced to Uganda by HPI in 1983, and has survived despite political and economic problems. It has since been adopted by numerous agencies, including the Ministry of Agriculture and International NGOs.

Over 5,000 families have benefited directly from significant increase in income and nutrition, resulting in dramatic improvements in housing and school attendance. Some 10,000 hectares of land have been improved or stabilised by the development of a sustainable small-holder dairy farming system. Over 50 community-based groups have been strengthened and these are an engine for rural development. The status of women has been enhanced as over half of the livestock owners are women, many of who are widows with large families.

Source: Carolee Black

17. Zimbabwe: Chivi Food Security Project

This ITDG project is located in southern Zimbabwe, which falls into Zimbabwe's lowest categories of agricultural potential, and where drought occurs in three out of every five years. An approach which combined low-cost regenerative technologies with building farmers' capacities to participate in research, extension and within group structures has meant that now farmers report that their yields have more than doubled (up 100%) since the project was initiated in 1991. The main technologies are water harvesting (tied ridges and infiltration pits) and the adoption of clay pipes and ferro-cement rings for subsurface irrigation of women's vegetable plots. Some 35 women's garden clubs for raising and selling vegetables are now effective and families have become food secure with the greater range of produce spread through the year. According to some community participants *"food security is no longer a problem"*.

The multi-functional benefits of the project include farmers have acquired new skills for food production; local institutions have been strengthened in tackling their own problems; transformative training has increased confidence among local people, particularly poorest groups; increased involvement of women in community decision-making; greater capacity amongst farmers to articulate their needs to service providers, and research and extension systems have become more responsive to farmers' needs.

Source: Intermediate Technology Development Group

ASIA

1. Bangladesh: Integrated pest management for rice

Integrated Pest Management for rice in Bangladesh is being implemented through three projects (INTERFISH, NOPEST and GOLDA) that are supported by DFID and the EU and implemented by Care. They involve farmers attending farmer field schools (`schools without walls') during a whole rice season. They meet each week to learn new agro-ecological principles and concepts relating to rice, pest and predator management. Some 6000 farmer field schools have been completed, with about 150,000 farmers adopting more sustainable rice production on 54,000 ha. The programmes also emphasise fish cultivation in paddy, and vegetable cultivation on rice field dykes. Rice yields have improved by 5-7%, and costs of production have fallen owing to reduced pesticide use - some 80% of farmer field school participants no longer use pesticides. The fish-rice-vegetable systems have been shown to produce synergistic benefits: additional income from fish is $156/ha, from vegetables on dykes $23/ha, but fish and vegetables together bring an additional $250/ha. As a result, the 150,000 participating households are now food secure throughout the year.

Source: Desilles, 1999

2. China: Wheat-Maize Double Cropping Programme, Hebei Plain

The Wheat-Maize Double Cropping System project is located on Hebei Plain, northern China. It began in 1996 and is financially supported by the provincial government, Xinji County government, and the Science and Technology Committee of Hebei Province. After a successful field trials, the wheat-maize double cropping system was extended through model farms, videos and printed materials. Some 224,000 households have since adopted the technology on about 100,00 hectares. Yields have improved by about 10%, water use has been reduced by 30%, and fertilizer use reduced by 20%. As a result, net returns have improved by 30%.

Source: Liang Weili

3. China: fish in rice programme, Jiangshu Province

Rice-fish culture offers many benefits to rural households, economies and environments. At present, only 136,000 ha of the total area of 21 million ha of irrigated rice fields in South East Asia are used for aquaculture. Jiangsu province in China has more than 30 million mu (2 m ha) of rice fields, among which one third are suitable for rice-fish culture. The "The Extension Project of Large-scale, High-yielding, High-effective Techniques of Rice/Aquaculture in Jiangsu Province" project was developed by the provincial government in the mid-1990s, with multi-functional aims: to develop rice/aquaculture combined with reforming and ameliorating low-yielding paddies, ponds and waterlogging farmland for the purpose of increasing food production and income, promoting rural economy, and enriching farmers.

As a result, the rice aquaculture area in Jiangsu Province expanded from about 5000 ha in 1994 to reach 68,973 ha in 1997. In addition, the area of rice-crab culture expanded to 36,113 ha and rice-shrimp culture reached 13,867 ha. The economic returns of rice aquaculture are remarkable. In 1997 the unit profit of rice/aquaculture fields was 2.86 times that of mono rice cultivation in paddies. Rice-aquaculture systems are low cost, and provide rapid economic returns. They provide an additional source of food and income in rural areas, producing 50 kg of fish per mu.

Rice-aquaculture farming systems also maintain the ecological balance of rice field ecosystems. The rural

environment can be improved through the use of non-pollution agriculture – the use of agricultural chemicals is greatly reduced. Rice-fish culture also helps eliminate mosquito larva harmful to human health. Japanese encephalitis and malaria are transmitted by mosquitoes found in a wide belt of Asia, and their prevention depends on improved environmental manipulation to stop mosquito breeding in rice fields. Rice-fish systems provide good control of mosquito incidence. In Quanzhou County, incidence of malaria fell from 11.6 / 100,000 to 0.1 / 100,000 as the area of rice-fish cultivation grew from zero to 43% over a ten year period.

Source: Li Kangmin, 1998

4. China: East Gansu Sustainable Agricultural Techniques for Effective Use of Rainfall Resources Project

The East Gansu region is part of the 51 million ha dryland area in the Northwest of China. This sustainable agriculture project was initiated by the Gansu Academy of Agriculture in 1991 as part of Ninth Five-year National Development Plan aimed at achieving food security and self-sufficiency. It promotes more efficient use of rainfall through run-off collection techniques, water storage tank construction, devices for lifting and conveying water, microcatchment water conservation with film mulching, and multiuse crop products and bi-products for livestock. The number of farm households adopting sustainable agriculture is now 100,000 on an area of some 70,000 ha. Cereal yields have increased substantially -wheat by 40% (from 3 to 4.2 t / ha), and spring maize by 38% (from 6 to 8.3 t / ha). There is greater availability of both irrigation water and drinking water for people and animals. Additional benefits include reduced soil erosion, decreased pesticide and fertilizer use, increased social capital formation through farmers' mutual aid groups, and increased capacity of women who now play a major part in fruit and vegetable management and livestock rearing.

Source: Fan Tinglu

5. India: Indo-German Watershed Development Programme, Maharashtra

The IGWDP is an integrated environmental regeneration programme implemented by village self-help groups in the drought-prone state of Maharashtra. It is assisted by the German development agency GTZ and development bank KfW, and administered by NABARD (the National Bank for Agriculture and Rural Development) and the locally Watershed Organisation Trust. The programme works in partnership with 51 local NGOs and 77 village self-help groups, and has seen sustainable agriculture implemented on some 92,000 hectares, with the involvement of about 20,000 farm households. There has been a marked improvement in agricultural productivity (dryland yields up 250%; milk production up) and natural resource productivity (wells wet for more months per year; increased fodder grass production), which in turn has increased incomes and food security (household grain production up 40-100%), reduced seasonal migration, increased school attendance, and a led to a wider sense of hope and confidence amongst rural people. Many new village institutions have also been organised by rural people, including grain banks, women's groups, youth groups, credit unions, dairy cooperatives, and agricultural cooperative societies.

Source: Lobo and Korchendorfer-Lucius, 1998; IGWDP, 1998

6. India: KRIBHCO Indo-British Rainfed Farming Project (West)

This participatory soil and water conservation project is supported by DFID and is based in upland areas of Gujarat, Rajasthan and Madhya Pradesh. Land degradation is severe, soils are poor, and agricultural production is usually inadequate to support most families. The project works with local groups of 15-25 households on water-harvesting, tree planting, and grazing land improvements. There are now 232 groups in 70 villages: funds raised by each group now average Rs 650, generated mostly from increased agricultural production (giving a total fund base of Rs 151,000). Basic grain yields (rice, wheat, pigeonpeas and sorghum) have improved from 400 kg / ha to 800-1000 kg / ha. The increased fodder grass production from the terrace bunds is also valued highly. The improved water retention (water tables have risen by 1 metre over the past 3-4 years) means that a *rabi* season crop is now possible for many farmers, turning an unproductive season into a productive one, resulting in a sharp decrease in seasonal out-migration.

Source: Smith, 1999

7. India: Government of Rajasthan Watershed Development Programme

The Watershed Development and Soil Conservation Department of the Government of Rajasthan was set up in 1991 to implement a participatory approach for integrated watershed development. Since the 1940s, groundwater levels had fallen dramatically, forests had become degraded, and community institutions undermined. But despite considerable expenditure on soil conservation, the impacts were poor, as Krishna observed: *"field observations confirmed... near zero maintenance by the beneficiaries"*. The GoR recognised the need to involve local people, and has since facilitated the formation of 15,000 watershed users' groups, with at least three million hectares (possibly as high as 10-15 m ha) under sustainable practices. The technologies are low-cost and based on indigenous and biological technologies, including strips of vetiver and other grasses on the contour; contour bunds and contour cropping; field bunds; drainage line treatment; and regeneration of common lands with shrubs and trees. Sorghum and millet yields have more than doubled to 400-875 kg / ha (without addition of fertilizers); and grass strips have improved yields by 50-200% to 450-925 kg / ha.

Source: Source: Krishna et al, 1997; Uphoff et al, 1999; Krishna, 1999

8. India: The Society for People's Education and Economic Change, Tamil Nadu

SPEECH has been working in Kamarajar District of Tamil Nadu since 1986, and has helped to build and strengthen local groups and institutions in 45 villages. The region is known for its acute droughts, erratic monsoons, poor services and entrenched socio-economic and cultural division. Village groups, or *sanghas*, have adopted a range of sustainable agriculture approaches to make better use of existing resources. Water harvesting

has been particularly effective, as it not only brings previously abandoned land into production, but also means sufficient water can be saved for an additional wet rice crop on the small amount of irrigated land. Milk cows have been introduced, bringing particular benefits to women and children. Sorghum and millet yields have doubled, and extra crops and fruit and timber trees are being cultivated. As *sanghas* become more confident, they begin to develop new activities, such as providing for health care, building roads, and running savings and credit schemes. Representatives are elected to a Cluster Level Governing Council, an independent society that provides a platform for local groups to address emerging concerns.

Source: John Devavaram; Devavaram et al, 1999

9. India: Water users' associations and participatory irrigation management in Gujarat

In July 1995, the government of Gujarat adopted a resolution announcing the participatory irrigation management (PIM) programme. It envisages a complete turnover of operation and maintenance of canals to water users associations (WUA). While the canals remain government property and major repairs continue to be the responsibility of the irrigation department, the responsibility of the day-to-day functioning of the system is of the WUA. Planning of crops, allocation of water available for irrigation, fixing the water rates, collecting the water demand forms and water charges from the individual members and disciplining the defaulters are the other responsibilities of the WUA under the PIM. After carrying out repair and rehabilitation, works on the canal network the management is to be `turned over' to the WUAs.

In the pilot phase of the PIM programme, thirteen projects were selected to experiment and learn from the new approach. This programme focuses on the formation of user cooperatives and the development of links between different actors (participant farmers, NGOs and government). The NGOs mobilize and organize farmers to set up a WUA and guide it during its formation and through subsequent stages. However, technical help, cooperation and guidance from the department remains an important link. The participating farmers form and manage the Association, they also make a fixed contribution toward the initial expenses of repair and rehabilitation of the system. It is generally understood and appreciated that the NGOs have been particularly adept at developing cooperative spirit among the participants.

The most outstanding results include:

- Peoples' participation grew gradually in the WUA, with strong emphasis on "Learning by Doing" (a concept that emerged during the process of implementation of the PIM);
- The higher (than government) water charges levied by the WUA underwent a series of negotiations proving empowerment of people, and at the same time water pricing to be dynamic and difficult process;
- The importance of motivation in a participatory programme, and the NGO's role in this;
- Phasing strategies of the process of implementation of the programme provided invaluable lessons for replication;
- The importance of taking in to account the dynamics of caste, class, inter and intra-village differences in the society while implementing a programme;
- The important and crucial role of documenting the process of implementation by a researcher - a parallel research effort was found to helpful in introducing mid-course corrections in the implementation of the programme.

Source: Anil Shah

10. India: National IPM Programme

Like a range of other Asian countries, the national IPM programme in India uses farmer field schools to build farmer capacity and knowledge on agroecology. Some 77,000 farmers have been trained in 2600 FFS on rice, cotton, sugarcane and oilseeds. A further 12,400 demonstrations have been conducted after FFSs to help spread the concepts and practice of IPM. FFS are also being used to address wider soil, water and nutrient management issues. In Tamil Nadu, for example, farmers are experimenting with row planting, planting distance, biofertilizers (*Azospirillum, Azolla*), organic manures and basal fertilizer applications. Farmers' adoption of biocontrol agents (eg *Trichogramma*, neem) means that conventional pesticide use has fallen by 50% on average. Incomes have increased by Rs 1000-1250 / ha, and rice yields have increased by 250 kg / ha.

Source: Eveleens et al, 1996

11. Indonesia: National Integrated Pest Management for Rice Programme

In 1986, a Presidential Decree banned 56 brands of pesticide on rice and established a national IPM programme, with the aim of making farmers experts in their own fields through the use of farmer field schools. One million farmers have now attended about 50,000 FFSs, the largest number in any Asian country. The programme is supported by FAO, the World Bank and USAID, and operates in 12 of the 26 provinces, including all 6 rice-bowl provinces. The impacts have been substantial: one survey of 2000 farmers found that rice yields had increased by 0.5 t / ha on average, with lower variation in year-on-year yields. At the same time, the number of pesticide applications had fallen from 2.9 to 1.1 per season, with dramatic reductions in the use

of banned products. On average, a quarter of all farmers are now applying no pesticides, rising to a half in some villages. Many of the FFSs have continued to be active as farmer IPM groups, meeting to discuss farming problems; monitor pest and predator populations in their villages; conduct village wide campaigns to control rats, extend IPM to neighbouring villages; and run savings and credit programmes.

Source: van der Fliert, 1993; Eveleens et al, 1996; Kenmore, 1999

12. Nepal: Jajarkot Permaculture Programme

This promotes sustainable food production in 31 villages of Jajarkot Khalanga, and is supported by ActionAid Nepal. A community-based process builds on the skills and knowledge of local people and professionals through social capital formation. The main impacts of the programme are increased food production – some 40% of the 580 participating households, organised into 44 groups, are now entirely food self-sufficient through increased used of regenerative agriculture technologies, including green manures, composting, intercropping, agro-forestry, and increased diversification of farm systems through incorporation of fruit trees, bees, sheep, rabbits, cotton, flowers; and intensification of kitchen gardens. The programme also works with smokeless stoves, pit latrines, community groups for managing local savings and credit system, support to small businesses, strengthened adult education and access to health facilities.

Source: JPP, 1997-99; Chris Evans, pers. comm. 1999

13. Philippines: Contour Farming on Sloping Lands in Claveria

Claveria is in northern Mindanao, and is characterised by acid soils on sloping lands with severe erosion. ICRAF and local research and extension agencies worked with farmers on the development of a variety of contour farming technologies. The project began with leguminous trees, but after relatively weak uptake, developed more locally suited methods in the form of natural vegetative strips combined with ridge tillage. A wide range of perennial crops have been tested by the 2000 farmers working in the 80 local groups formed by the project, including fruits, coconut, mulberry and fast-growing timber species. On farms with soil improvement (some 6000 ha), maize yields have improved 15-25% and land values by 35-50%.

Source: Garrity, 1999; Fujisaka, 1999

14. Philippines: Integrated Pest Management for Highland Vegetables

The CABI Bioscience IPM for Highland Vegetables project was set up in 1994 and is funded by the Asian Development Bank. Insecticide resistance and human health problems had become severe, and so the IPM project set up farmer field schools to increase awareness about the harmful effects of pesticides, to increase knowledge of natural enemies, and to encourage discussion on best husbandry practice amongst farmers. The project reached 1719 farmers in 65 FFS groups, with 48 trainers trained, mainly from local government. As a result, a range of alternative pest control methods was developed by farmers. There has been an 80% decrease in pesticide use in the wet season (55% fall in the dry season) and the synthetic fertilizer rate has halved, giving farmers a net rise in income of 17%. Vegetable yields have also increased by about 20%. Farmer field schools are now considered locally to be a good investment by municipal authorities.

Source: Lim Guan Soon; Peter Ooi

15. Sri Lanka: National Integrated Pest and Crop Management Programme

The INTEGRATED project is an IPM extension programme working in a wide range of agro-ecological zones of Sri Lanka. It is implemented by Care International, with funding from the EU and DFID. The project uses farmer field schools to promote IPM, and has trained 4300 farmers in sustainable rice and vegetable production methods. Some 55,000 farm households on about 33,000 ha have now adopted sustainable agriculture, with substantial reductions in insecticide use (2.9 to 0.5 applications per season for rice). Yields have increased by 12-44% for rice, and 7-44% for vegetables, depending on location in the country.

Source: Jones, 1999

16. Sri Lanka: Gal Oya and Mahaweli Participatory Irrigation Schemes

The participatory approach to irrigation system rehabilitation was pioneered in the Gal Oya scheme, and had the effect of changing many professionals views about farmer involvement in

water management. At the beginning of the project, Gal Oya was the largest and most run-down scheme in Sri Lanka. The approach was founded on building local institutions for water management, taking groups through a process of problem identification and collective action, leading to formal organisation. Some 33,000 water users' associations (comprising at least 500,000 farmers on 0.5-1 million hectares) were formed in both Gal Oya and Mahaweli. The economic benefits arise mainly from increased water use efficiency, enabling farmers to increase cropping intensity and so raise total production. There were also some increases in rice yields. As farmers took control, so the number of complaints received by the Irrigation Department about water distribution fell to nearly zero. Since project completion, farmers' organisations have maintained themselves, progressed institutionally, and developed their own capacity for dealing with problems.

Sources: Uphoff, 1999; Wijayaratna and Uphoff, 1997

17. Vietnam: IPM in rice in Mekong Delta

Researchers with the International Rice Research Institute, Ministry of Agriculture and Rural Development (Vietnam) and Visayas State College of Agriculture (Philippines) have been engaged in the past eight years in a unique and successful initiative to encourage the adoption of more sustainable rice production in the Mekong Delta, Vietnam. Surveys in the early 1990s showed that insecticide use by farmers was high, particularly to control leaf-feeding larvae that caused visible defoliation. Farmers believed that such visible damage caused yield loss, but researchers had discovered that leaf-damage during the vegetative stages of rice rarely reduce yields. Indeed, use of insecticides was more likely to kill beneficial insects, and lead to outbreaks of secondary pests.

Through an innovative media campaign backed with farmer-field schools, farmers in Long Am Province were encourage to test the heuristic *"insecticide spraying for leaffolder control in the first 40 days after sowing is not needed"*. The campaign distributed 380,000 leaflets and 35,000 posters, organised 1390 demonstrations and broadcast a radio drama 1550 times. This reached 97% of the 20,000 farmers in the study region, and 82% of those on the whole province – a total of 172,000. In the two and a half years after the campaign, mean insecticide spraying fell from 3.35 to 1.56 sprays per farmer per season. Farmers' perceptions had changed substantially – 77% had stopped early season spraying, and 20-30% had stopped using insecticides altogether.

Other provinces in the Mekong Delta adopted the approach, and their campaigns have reached 92% of the 2.3 million farmers – who have now reduced spray frequencies to one per season (a 70% reduction). Rice yields have not changed during this period – remaining at about 4t / ha. Researchers concluded that the two interventions – detailed understanding from the farmer field schools, and spread through the media campaign, play complementary roles in changing both farmers' beliefs and practices. Researchers are now exploring ways to develop targeted advice for other phases in the rice cycle – as the total potential audience of rice farmers in Asia is more than 200 million.

Sources: K L Heong; Heong et al, 1998; Escalada et al, 1999

18. Vietnam: National IPM for Rice Programme

Vietnam has seen spectacular progress with its implementation of the FFS approach, with some 250,000 farmers trained since 1992. The programme began by focusing on rice, but quickly spread to vegetables, soybean, cotton, tea and rice-fish culture. It works in all 53 provinces, with nearly 9000 FFS organised by the national programme, with about one third funded by local sources and NGOs. In many villages, IPM graduates form IPM clubs, which meet to discuss IPM, conduct collaborative research, and test new practices (eg fish in rice, IPM on vegetables). The programme has seen rice yields increase by about 3%, pesticide expenditure fall by 80%, pesticide application events fall by 79% (from 1.1 to 0.23 per season), and urea use fall by 10%. Farmers have also changed the timing of fertilizers, spreading them more evenly though the season. Long-term studies show that insecticide applications remain at about 25% of the former level. National policy support has played a vital role, including 1993 legislation on plant protection, a clean vegetable programme for organic production, limits on the import of restricted pesticides, pesticide bans, bans on new pesticide factories, and the establishment of a national cross-ministry IPM Steering Committee

Source: Eveleens et al, 1996

19. The Rice-Shrimp Farming Systems in the Mekong Delta, Vietnam

This system is dominant in the coastal line area of My Xuyen district, Soc Trang province where brackish and saline water prevails during the dry season. This system was perfected in 1989-1990. Farmers can get more income from this system instead of just having one rice crop. The rice-shrimp farming system consists of the following steps:

i) Field construction

The field is well constructed as described in the rice-fish system. The surrounding dike usually is 2.5 to 3.0 m wide at surface, 3.5 to 4.0 m at base, and 0.8 to 1.0 m high. The trench system is constructed parallel to the surrounding dike. A shallow drainage (ditch) system inside is also constructed to connect with the trench system. The trench is 2.0 to 2.5 m wide at surface, 1.2 to 1.8 m at base, and 0.6 to 0.8 m deep.

ii) Rice component

The rice field is prepared during the start of the rainy season. Saline water is let out of the field and the soil is flushed by the rainwater. Initially the soil salinity might be high. However, after a few rains the salinity is reduced. Flushing period takes one or two months depending on the rain intensity. The seedling nurseries are prepared in early rainy season. Rice fields are cleaned of weeds and algae, without tillage, before transplanting in July and sometimes continues until early August. IR42 is a typical variety used in this system. Seedlings are transplanted at the age of 30 to 40 days. The yield of IR42 is 4.3 t/ha.

iii) Shrimp component

After harvesting the rice crop near the end of the rainy season, while the soil is still wet and the river water has not yet become saline, farmers allow river water to enter the field to raise shrimp (*Penaeus* spp. or *Macrobrachium* spp.) until December. The first shrimp harvest is done after the end of the rainy season. Again, the field is prepared for rearing another crop of shrimp in December and this field preparation may continue until January. Intake of saline water into the field is done at high tide. Water management is important during growing period. Exchange of water is done one or two times a week to create a continuous flow of water in the field. Stocking of *Penaeus* is carried out between January and March. Stocking density is 0.84 juveniles/sq m. Feeding shrimp with cassava, coconut meal, milled rice, and fish meal is common. Harvesting of shrimp is done between April and June. Average yield of shrimp is about 190 kg per ha.

The gross margin (without labour costs) of this system is at US$1,223/ha/year. Total labour requirement of the system is 194 person-days and gross margin per total labour-day is at US$ 6.3. Compared with rice monoculture, the gross margin is only US$514/ha/year.

Source: Vo-Tung Xuan

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Cuba's security in fresh produce

Friday, September 12, 2003
By Eliza Barclay

Across the Florida Straits from Miami in the capital city of a country ranked 90th in GDP by the United Nations Development Program (UNDP), students in Havana, Cuba, are munching on a wide variety of fresh fruits and vegetables, picked by their own hands in the school garden, or grown nearby in urban organic gardens.

Courtesy Eliza Barclay
This award-winning *organoponico* is on Quinta Avenida in the Miramar neighborhood of Havana. The garden provides cilantro, several varieties of lettuce, medicinal herbs, and bok choi to neighbors and to a school two blocks away.

In the early 1990s, the average Cuban dinner table did not boast a spread even remotely close to the bounty enjoyed by many today. During these years, when foreign economic support disappeared with the collapse of the Soviet Union, average caloric and protein intake dropped to nearly 30 percent below 1980s levels.

Faced with the possibility of widespread starvation, the Cuban government foresaw that a full-scale mobilization of domestic resources, both human and natural, would be required in order to increase production to meet the demands of a hungry populace. And with few options to import food given the stringency of the U.S. embargo, Cuba turned over a new leaf by converting almost entirely to an organic production system within 10 years.

Cuba's nationwide commitment to food self-sufficiency without reliance on chemical or mechanical technologies has borne some startlingly successful results, not only in terms of food production but also in the development of a more personalized food culture, woven deeply into patterns of food consumption, nutrition, and community.

These trends, which many sustainable agriculture experts enthusiastically champion, also appear to be on the brink of a major confrontation with the powerful forces of the global market, from which Cuba was virtually exempt until 2001, when U.S. policy toward agricultural exports to Cuba began to shift slightly. The strength of Cuba s food security, with all its growing bureaucratic and market support, will inevitably be put to the test as small but increasing concessions are made to expand trade between Cuba and its closest potential trading partner, the United States.

Collapse and Revival

In 1989, as a result of the collapse of the Soviet Union and the subsequent retraction of petroleum, farm equipment, food subsidies, and the preferential trade relationship that had come with Soviet support of the Cuban state, the country lapsed into a phase of dire food, energy, and morale shortages, known as the "Special Period" or *periodo especial.*

Cuba had been under the thumb of various colonial empires from Spain and the United States since the 16th century. The Soviet Union, during its phase of supporting Cuba, continued with a system that encouraged the production of sugar and tobacco for foreign markets, leaving little land for food production. In 1989, however, no one came to scoop up the Caribbean island and ladle in more subsidies, and the Cubans felt a new sense of excision from the global market.

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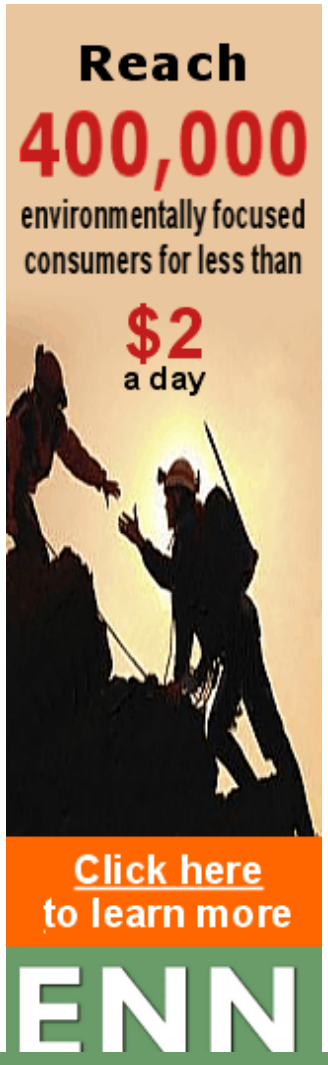

Cubans from all walks of life suffered during this period; shortages were reminiscent of war time, though the country was diplomatically at peace. The crisis was worsened by the tightening of the U.S. trade embargo through two pieces of legislation in 1992 and 1996, zapping any possibility of Cuba looking outside its boundaries for assistance except to a few friendly governments like Venezuela and Nicaragua.

The agricultural model inherited from the 1980s was not a particularly advantageous one. Farming in Cuba before the Special Period was characterized by large quantities of chemical inputs in a highly monocultural and intensive system. In this period, Cuban farms had been using roughly 200 kilograms of nitrates per hectare. Without the Soviets delivering these expensive inputs at subsidized rates, Cuban farmers and average hungry citizens had no choice but to look to alternative models in developing a new agricultural system.

After 10 years of hard work and major food shortages, most Cubans can feel secure in having access to fresh, nutritious food through the extensive network of intensively cultivated urban gardens, or *organoponicos*, and state-run farms and cooperatives outside the cities. They can also take comfort in the fact that nearly all the food they eat comes from a self-sufficient agricultural system that relies only minimally on pesticides, fertilizers, or expensive machinery.

Given the highly restrictive nature of the U.S. embargo on trade with and from Cuba, the Cubans have been forced to virtually sink or swim in terms of procuring or growing food. Because of the terms of the trade sanctions, Cuba has been ineligible to receive food aid from international aid agencies.

Peter Rosset, co-director of Food First/Institute for Food and Development Policy based in Oakland, Calif., has been researching food issues in Cuba since the early 1990s. He said, "Cuba has resisted three things: the blockade of the U.S. embargo, the fallout of the Soviet Union, and the industrial green revolution and economic globalization that has taken its toll elsewhere in the world."

Fortunately, with a combination of solid scientific expertise and institutional will, Cuba was able to replace conventional farming practices with more practical and affordable alternatives. By charting new courses in research, land management, and market supply, government officials and scientists were able to avert a full hunger crisis and activate farmers and urban citizens to dedicate themselves to meeting food demands.

Key ingredients in the new agricultural model are the urban agriculture movement; traditional farming techniques like composting and intercropping (growing two crops together that benefit each other by warding off particular pests); new nontoxic biopesticides and biofertilizers; worker-managed collectives; quotas for farmers to insure adequate supply for the whole country; and opening farmers' markets where excess food crops can be sold by farmers for profit.

The government also addressed land availability for domestic food production by redistributing parcels of land that had formerly operated as cane plantations for the sugar industry, which exchanged its products for oil from the Soviet Union. Each of these initiatives has created a fertile environment for technological innovation in organic production and economic incentives that encourage more people to farm.

According to Rosset, "Cuba has been able to change farming techniques in order to survive, but it has been an ongoing process of institutionalizing the farming alternatives."

Throughout the past decade, government agencies like the Ministries of Agriculture, Health, Education, and Communication have been developing increasingly coordinated efforts to integrate agricultural extension education, nutrition education, and outreach to the Cuban people. The government has committed to make fresh fruits and vegetables available to every citizen, but so far, they haven't quite managed to do this. Cuban authorities say that at this point, availability is not so much of an issue. Instead, they are now working on ways to bring down the prices so that even the poorest consumers can enjoy the bounty.

Urban Agriculture on the Rise

Cuba's commitment to sustainable farming practices demonstrates how huge improvements in food production can be achieved even under stressful economic and environmental conditions. Urban agriculture has played an integral role in achieving food security, and Cuba is at the vanguard of the global urban agriculture movement. In 2002, Cuba produced 3.2 million tons of food in urban farms and gardens.

In 2002, more than 35,000 hectares (86,450 acres) of urban land were dedicated to the intensive production of fresh fruits, vegetables, and spices. According to Dr. Nelso Campanioni Concepción, deputy director of the National Institute for Fundamental Research on Tropical Agriculture (INIFAT), "The goal of urban agriculture is to gain the

most food from every square meter of available space. The secret to the success of urban agriculture in Cuba has been the introduction of new technologies and varieties and an increase in areas farmed."

Another factor favoring urban agriculture is that Cuba does not have the transport infrastructure especially since the Soviets stopped delivering fuel to deliver large quantities of food from rural areas to the cities on a regular basis. This means that urban residents benefit not only from feeding themselves but also by guaranteeing the freshness of their daily sustenance.

Extra food is shared in the community. Retirement home and hospital kitchens receive anywhere from a steady supply to seasonal, fluctuating donations from neighborhood gardens. These gardens, coupled with the comprehensive rural and suburban farms, play a critical role in completing the sense of food security that Cubans now enjoy.

Nutritious and Delicious

Filberto Samora, the administrator of one of the oldest *organoponicos* in Havana which won recognition from President Fidel Castro, said, "This *organoponico* is very much a part of the neighborhood. We give food to the school two blocks away, and all the neighbors come to buy food from the stand."

Samora's *organoponico* grows bok choi, lettuces, and cilantro, but farmers from outlying areas of Havana are also allowed to sell their produce at Samora's stand. The *organoponico* facility has also begun to produce its own seeds and compost for distribution to other farms in Havana.

The farmstands and neighborhood gardens have not only provided a consistent source of fresh and affordable food, but the fact that fresh produce is now readily available has also played a critical role in guiding the Cuban diet in a more healthy direction.

"After the Special Period, once food was plentiful again, people were stuffing their faces with foods like meats and sugars that they had been deprived of," said Madelaine Vásques Gálvez, owner of El Bambú, a vegetarian restaurant outside Havana, and editor of *Germinal*, a journal that focuses on food education for sustainability. "We now know that there are many diseases associated with diets high in sugar and fat."

Vásques has been involved with ecological cuisine in Cuba for 11 years. Her cooking style utilizes a wide range of native fruits and vegetables grown in the restaurant s own permaculture garden. Permaculture is an approach that emphasizes holistic design and maintenance so that the food system mirrors a biologically productive ecosystem. In other parts of the restaurant as well, Vásques sticks to ecological principles. For example, her stoves are powered by solar panels.

The Cuban diet has not always included copious amounts of vegetables, especially not those of the leafy green persuasion. As strange as it seems to some Cubans, especially the older generations whose diets have primarily depended on Soviet subsidies, vegetables appear to be catching on. There are now nine vegetarian restaurants in Havana, and urban gardeners from all walks of life expound upon the importance of fresh food.

The government and market have worked together to both feed the people and nurture the soil, and so diversity in diet has evolved, mirroring the crop diversity in the field. In the past few years, the Ministry of Health has become strongly supportive of and involved with urban gardening and the diversification of the Cuban diet.

Samora said, "It is still too early to determine where the new program of educating children on the healthy aspects of vegetables is really having an impact on their concept of what tastes good. We do find, though, that they want vegetables just as much as their parents when they come to the stand."

Secure in Food, but Secure in Future?

The news of Cuba's success has been slowly leaking out since the early 1990s, and the country is beginning to take on legendary status as a model for sustainable agriculture and local food production in the eyes of environmental advocates, farmers, and development specialists. Already lauded for years by the steady stream of sustainable farming gurus from around the world who have made the pilgrimage to observe the success of organic and local food production, Cuba's experiment with sustainable agriculture has succeeded beyond its trial period.

American farmers have been shuttled to Cuba in "fact-finding missions" and "reality tours" by crafty NGOs who have obtained the highly coveted U.S. Department of Treasury Office of Foreign Assets Control (OFAC) licenses allowing them to sponsor travel to Cuba for educational purposes. Whether many of these trips will be allowed to continue is unclear; in March 2003, OFAC announced the end of people-to-people

exchanges. Most groups who have had the appropriate licenses are scheduled to lose them by December 2003.

But a rapidly approaching future of shifting economic opportunities poses serious questions and potential risks to this Cuba s model, regarded as precious by so many of its advocates.

Despite the embargo, in 2000, President Clinton signed the Trade Sanctions Reform and Export Enhancement Act (TSRA), which re-authorized the direct commercial export of food products and agricultural products via cash transactions from the United States to Cuba but not from Cuba to the United States.

In September 2002, after the U.S. Food and Agribusiness Exhibition took place in Havana, the Cuban government purchased more than $91.9 million in food and agricultural products from subsidiaries of U.S. companies based in Latin America and Canada and directly from U.S. companies.

Archer Daniels Midland (ADM), one of the world's largest exporters of cereal grains and oilseeds, signed a $19 million contract for soybean oil, soybeans, soy proteins, corn, margarine, and rice. In 2001, ADM s lobbying combined with wreckage in Cuba after Hurricane Michelle was the tipping point that persuaded the Bush Administration to allow the first sale of goods directly from the United States to Cuba since 1962.

The American Corn Growers Association (ACGA), which, to date, has not taken up trade negotiations with Cuba, would be interested in trade sometime in the future, said its chief executive officer.

"We should be exporting to any nation that needs food," said CEO Larry Mitchell.

With Cuba's well-documented ability to feed itself, why would the Cuban government be interested in spending $91.9 million on food imports?

John S. Kavulich II, president of the U.S. Trade and Economic Council based in New York City, said, "There is a strong political component to the Cubans' decision to purchase food products from us. Of the products purchased since 2001, nearly all of them are available from other sources at better prices."

Kavulich cited rice as an example. The Cubans could buy rice from Vietnam at a significantly lower price, but they choose to purchase from purveyors like ADM instead.

Food First's Rosset agrees. "I believe the Cubans are buying from the U.S. as a political gesture. They hope the food corporations will lobby the U.S. government on their behalf to lift the embargo."

Aside from the disruption in self-sufficiency, there is also growing concern that if the embargo is eventually lifted, global agricultural giants will persuade farmers to drop their organic methods in favor of high pesticide and fertilizer usage.

However, Dr. Nelso Campanioni Concepción of INIFAT responded: "We are not going back. We will increase production, but we will not degrade the environment doing it."

Speculating on the possible institutional reactions to a global market that peddles genetically engineered seeds, pesticides, and fertilizers, Rosset said, "There is a possibility of a negative impact on the Cuban model. There may be a short term increase in pesticide use and a stronger interest in biotechnology, but they may not last because they may not fulfill Cuban agricultural needs."

The members of the U.S. Trade and Economic Council Inc. seem to be chomping at the Cuban market bit. Kavulich said, "We have many members who have begun discussions with the Cubans over a wide array of products like food and hospitality services and biotech products."

As of now, the only McDonald's in Cuba is located on the Guantánamo Bay naval base, which has belonged to the United States since 1934. Cuban fast food chains exist and are popular, but they do not dominate the landscape or pepper the national concept of food, largely because advertising does not exist. If McDonald's and U.S.-produced corn, peas, and carrots in a can are eventually allowed into Cuba, it will still be up to the Cubans whether they prefer the foreign food to their own backyard-grown papayas, yucca, and lettuce.

Eliza Barclay is a freelance writer based in Washington, D.C.

Send comments to feedback@enn.com.

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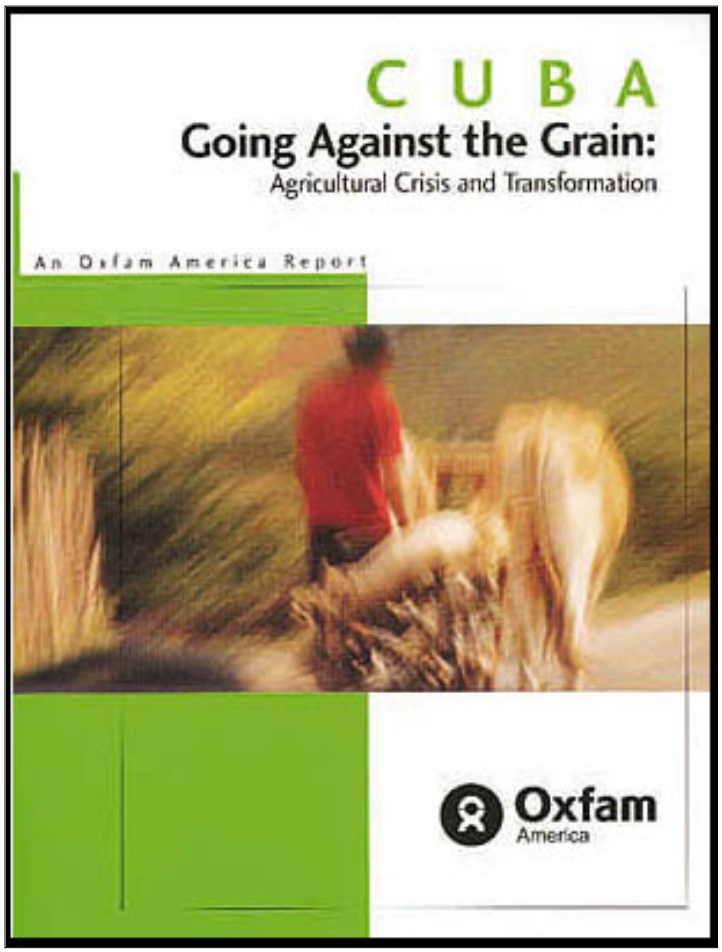
Cuba: Going Against the Grain
June, 2001

Agricultural Crisis and Transformation

By Minor Sinclair and Martha Thompson

A new Oxfam America report looks at how Cuba has successfully turned a severe food crisis into a sustained recovery in food production. Through a combination of sweeping reforms and innovations in ecological agriculture, Cuba's countryside has changed dramatically.



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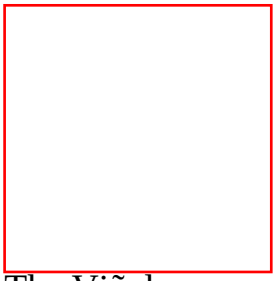
Sustainable Agriculture - A Case Study

When trade collapsed with the socialist bloc in late 1989 and 1990, the degree to which Cuba relied on monocrop agriculture proved to be a major weakness for the country. Searching for the most efficient solution, the Cuban government launched a national effort to convert the nation's agricultural sector from high input agriculture to low input, self-reliant farming practices on an unprecedented scale. By mid-1995 the food shortage had been overcome, and the vast majority of the population no longer faced drastic reductions of their basic food supply. In the 1996-97 growing season Cuba recorded its highest-ever production levels for ten of the thirteen basic food items in the Cuban diet. The Cuban experience illustrates that we can feed a nation's population well with a small or medium-sized farm model based on appropriate ecological technology, and in doing so we can become more self-reliant in food production.

The Viñales valley – situated in Pinar del Rio, the western-most province of Cuba (Photo: Bill Trumbull)

The Viñales valley (Photo: Bill Trumbull)



The Viñales valley (Photo: Bill Trumbull)

Summary
Our global food system is in the midst of a multifaceted crisis, with ecological, economic, and social dimensions. To overcome that crisis, political and social changes are needed to allow the widespread development of alternatives.

The current food system is productive—there should be no doubt about that—as per capita food produced in the world has increased by 15 percent over the past thirty-five years. But as that production is in ever fewer hands, and costs ever more in economic and ecological terms, it becomes harder and harder to address the basic problems of hunger and food access in the short term, let alone in a sustainable fashion. In the last twenty years the number of hungry people in the world—excluding China—has risen by 60 million (by contrast, in China the number of hungry people has fallen dramatically).

Ecologically, there are impacts of industrial-style farming on groundwater through pesticide and fertilizer runoff, on biodiversity through the spread of monoculture and a narrowing genetic base, and on the very capacity of agroecosystems to be productive into the future.

Economically, production costs rise as farmers are forced to use ever more expensive machines and farm chemicals, while crop prices continue a several-decade-long

downward trend, causing a cost-price squeeze which has led to the loss of untold tens of millions of farmers worldwide to bankruptcies.

Socially, we have the concentration of farmland in fewer and fewer hands as low crop prices make farming on a small scale unprofitable (despite higher per acre total productivity of small farms), and agribusiness corporations extend their control over more and more basic commodities.

Clearly the dominant corporate food system is not capable of adequately addressing the needs of people or of the environment. Yet there are substantial obstacles to the widespread adoption of alternatives. The greatest obstacles are presented by political-corporate power and vested interests, yet at times the psychological barrier to believing that the alternatives can work seems almost as difficult to overcome. The oft-repeated challenge is: "Could organic farming (or agroecology, local production, small farms, farming without pesticides) ever really feed the entire population of a country?" Recent Cuban history—the overcoming of a food crisis through self-reliance, small farms and agroecological technology—shows us that the alternatives can indeed feed a nation, and thus provides a crucial case study for the ongoing debate.

A Brief History

Economic development in Cuba was molded by two external forces between the 1959 revolution and the 1989-90 collapse of trading relations with the Soviet bloc. One was the U.S. trade embargo, part of an effort to isolate the island economically and politically. The other was Cuba's entry into the Soviet bloc's international trade alliance with relatively favorable terms of trade.

The U.S. embargo essentially forced Cuba to turn to the Soviet bloc, while the terms of trade offered by the latter opened the possibility of more rapid development on the island than in the rest of Latin America and the Caribbean.

Thus Cuba was able to achieve a more complete and rapid modernization than most other developing countries. In the 1980s it ranked number one in the region in the contribution of industry to its economy and it had a more mechanized agricultural sector than any other Latin American country.

Nevertheless, some of the same contradictions that modernization produced in other third world countries were apparent in Cuba, with Cuba's development model proving ultimately to be of the dependent type. Agriculture was defined by extensive monocrop production of export crops and a heavy dependence on imported agrichemicals, hybrid seeds, machinery, and petroleum. While industrialization was substantial by regional standards,

Cuban industry depended on many imported inputs.

The Cuban economy as a whole was thus characterized by the contradiction between its relative modernity and its function in the Soviet bloc's division of labor as a supplier of raw agricultural commodities and minerals, and a net importer of both manufactured goods and foodstuffs. In contrast to the situation faced by most third world countries, this international division of labor actually brought significant benefits to the Cuban people. Prior to the collapse of the socialist bloc, Cuba had achieved high marks for per capita GNP, nutrition, life expectancy, and women in higher education, and was ranked first in Latin America for the availability of doctors, low infant mortality, housing, secondary school enrollment, and attendance by the population at cultural events.

The Cuban achievements were made possible by a combination of the government's commitment to social equity and the fact that Cuba received far more favorable terms of trade for its exports than did the hemisphere's other developing nations. During the 1980s Cuba received an average price for its sugar exports to the Soviet Union that was 5.4 times higher than the world price. Cuba also was able to obtain Soviet petroleum in return, part of which was re-exported to earn convertible currency. Because of the favorable terms of trade for sugar, its production far outweighed that of food crops. About three times as much land was devoted to sugar in 1989 as was used for food crops, contributing to a pattern of food dependency, with as much as 57 percent of the total calories in the Cuban diet coming from imports.

The revolutionary government had inherited an agricultural production system strongly focused on export crops grown on highly concentrated land. The first agrarian reform of 1959 converted most of the large cattle ranches and sugarcane plantations into state farms.
Under the second agrarian reform in 1962, the state took control of 63 percent of all cultivated land.

Even before the revolution, individual peasant producers were a small part of the agricultural scene. The rural economy was dominated by export plantations, and the population as a whole was highly urbanized. That pattern intensified in subsequent years, and by the late 1980s fully 69 percent of the island's population lived in urban areas. As late as 1994 some 80 percent of the nation's agricultural land consisted of large state farms, which roughly correspond to the expropriated plantation holdings of the pre-revolutionary era. Only 20 percent of the agricultural land was in the hands of small farmers, split almost equally among individual holders and cooperatives, yet this 20 percent produced more than 40 percent of domestic food production. The state farm sector and a substantial portion of the cooperatives were highly modernized, with large

areas of monocrops worked under heavy mechanization, fertilizer and pesticide use, and large-scale irrigation. This style of farming, originally copied from the advanced capitalist countries by the Soviet Union, was highly dependent on imports of machinery, petroleum, and chemicals. When trade collapsed with the socialist bloc, the degree to which Cuba relied on monocrop agriculture proved to be a major weakness of the revolution.

Onset of the Crisis

When trade relations with the Soviet bloc crumbled in late 1989 and 1990, the situation turned desperate. In 1991 the government declared the "Special Period in Peacetime," which basically put the country on a wartime economy style austerity program. There was an immediate 53 percent reduction in oil imports that not only affected fuel availability for the economy, but also reduced to zero the foreign exchange that Cuba had formerly obtained via the re-export of petroleum. Imports of wheat and other grains for human consumption dropped by more than 50 percent, while other foodstuffs declined even more. Cuban agriculture was faced with a drop of more than 80 percent in the availability of fertilizers and pesticides, and more than 50 percent in fuel and other energy sources produced by petroleum.

Suddenly, a country with an agricultural sector technologically similar to California's found itself almost without chemical inputs, with sharply reduced access to fuel and irrigation, and with a collapse in food imports. In the early 1990s average daily caloric and protein intake by the Cuban population may have been as much as 30 percent below levels in the 1980s. Fortunately, Cuba was not totally unprepared to face the critical situation that arose after 1989. It had, over the years, emphasized the development of human resources, and therefore had a cadre of scientists and researchers who could come forward with innovative ideas to confront the crisis. While Cuba has only 2 percent of the population of Latin America, it has almost 11 percent of the scientists.

Alternative Technologies

In response to this crisis the Cuban government launched a national effort to convert the nation's agricultural sector from high input agriculture to low input, self-reliant farming practices on an unprecedented scale.

Because of the drastically reduced availability of chemical inputs, the state hurried to replace them with locally produced, and in most cases biological, substitutes. This has meant biopesticides (microbial products) and natural enemies to combat insect pests, resistant plant varieties, crop rotations and microbial antagonists to combat plant pathogens, and better rotations, and cover cropping to suppress weeds. Synthetic fertilizers have been replaced by biofertilizers, earthworms, compost, other organic

fertilizers, natural rock phosphate, animal and green manures, and the integration of grazing animals. In place of tractors, for which fuel, tires, and spare parts were largely unavailable, there has been a sweeping return to animal traction.

Small Farmers Respond to the Crisis

When the collapse of trade and subsequent scarcity of inputs occurred in 1989-90, yields fell drastically throughout the country. The first problem was that of producing without synthetic chemical inputs or tractors.

Gradually the national ox herd was built up to provide animal traction as a substitute for tractors, and the production of biopesticides and biofertilizers was rapidly stepped up.

Finally, a series of methods like vermicomposting (earthworm composting) of residues and green manuring became widespread. But the impact of these technological changes across sub-sectors of Cuban agriculture was highly variable. The drop-off of yields in the state sector industrial-style farms that average thousands of hectares has been resistant to recovery, with production seriously stagnating well below pre-crisis levels for exports crops. Yet the small farm or peasant sector (20 percent of farmed land) responded rapidly by quickly boosting production above previous levels. How can we explain the difference between the state- and small-farm sectors?

It really was not all that difficult for the small farm sector to effectively produce with fewer inputs.

After all, today's small farmers are the descendants of generations of small farmers, with long family and community traditions of low-input production.

They basically did two things: remembered the old techniques—like intercropping and manuring—that their parents and grandparents had used before the advent of modern chemicals, and simultaneously incorporated new biopesticides and biofertilizers into their production practices.

State Farms Incompatible with the Alternative Technologies

The problems of the state sector, on the other hand, were a combination of low worker productivity, a problem pre-dating the Special Period, and the complete inability of these immense and technified management units to adapt to low-input technology.

With regard to the productivity problem, planners became aware several years ago that the organization of work on state farms was profoundly alienating in terms of the relationship between the agricultural worker and the land. Large farms of thousands of hectares had their work forces

organized into teams that would prepare the soil in one area, move on to plant another, weed still another, and later harvest an altogether different area. Almost never would the same person both plant and harvest the same area. Thus no one ever had to confront the consequences of doing something badly or, conversely, enjoy the fruits of his or her own labor.

In an effort to create a more intimate relationship between farm workers and the land, and to tie financial incentives to productivity, the government began several years ago to experiment with a program called "linking people with the land."

This system made small work teams directly responsible for all aspects of production in a given parcel of land, allowing remuneration to be directly linked to productivity. The new system was tried before the Special Period on a number of state farms, and rapidly led to enormous increases in production. Nevertheless it was not widely implemented at the time.

In terms of technology, scale effects are very different for conventional chemical management and for low external input alternatives. Under conventional systems, a single technician can manage several thousand hectares on a "recipe" basis by simply writing out instructions for a particular fertilizer formula or pesticide to be applied with machinery on the entire area. Not so for agroecological farming. Whoever manages the farm must be intimately familiar with the ecological heterogeneity of each individual patch of soil. The farmer must know, for example, where organic matter needs to be added, and where pest and natural enemy refuges and entry points are. This partially explains the inability of the state sector to raise yields with alternative inputs. Like the productivity issue, it can only be effectively addressed through a re-linking of people with the land.

By mid-1993, the state was faced with a complex reality. Imported inputs were largely unavailable, but nevertheless the small farmer sector had effectively adapted to low input production (although a secondary problem was acute in this sector, namely diversion of produce to the black market). The state sector, on the other hand, was proving itself to be an ineffective "white elephant" in the new historical conjuncture, incapable of adjusting.

The earlier success of the experimental "linking" program, however, and the success of the peasant sector, suggested a way out. In September 1993 Cuba began radically reorganizing its production in order to create the small-scale management units that are essential for effective organic-style farming. This reorganization has centered on the privatization and cooperativization of the unwieldy state sector.

The process of linking people with the land thus culminated in 1993, when the Cuban government issued a decree terminating the existence of state farms, turning them into Basic Units of Cooperative Production (UBPCs), a form of worker-owned enterprise or cooperative. The 80 percent of all farmland that was once held by the state, including sugarcane plantations, has now essentially been turned over to the workers.

The UBPCs allow collectives of workers to lease state farmlands rent free, in perpetuity. Members elect management teams that determine the division of jobs, what crops will be planted on which parcels, and how much credit will be taken out to pay for the purchase of inputs. Property rights remain in the hands of the state, and the UBPCs must still meet production quotas for their key crops, but the collectives are owners of what they produce. Perhaps most importantly, what they produce in excess of their quotas can now be freely sold on the newly reopened farmers markets. This last reform, made in 1994, offered a price incentive to farmers both to sell their produce through legal channels rather than the black market, and also to make effective use of the new technologies.

The pace of consolidation of the UBPCs has varied greatly in their first years of life. Today one can find a range from those where the only change is that the old manager is now an employee of the workers, to those that truly function as collectives, to some in which the workers are parceling the farms into small plots worked by groups of friends. In almost all cases, the effective size of the management unit has been drastically reduced. It is still too early to tell toward what final variety of structures the UBPCs will evolve. But it is clear that the process of turning previously alienated farm workers into farmers will take some time—it simply cannot be accomplished overnight—and many UBPCs are struggling. Incentives are a nagging problem. Most UBPCs are stuck with state production contracts for export crops like sugar and citrus.

These still have fixed, low prices paid by state marketing agencies, in contrast to the much higher prices that can be earned for food crops. Typical UBPCs, not surprisingly then, have low yields in their export crops, but also have lucrative side businesses selling food produced on spare land or between the rows of their citrus or sugarcane.

Food Shortage Overcome

By mid-1995 the food shortage had been overcome, and the vast majority of the population no longer faced drastic reductions of their basic food supply.

In the 1996-97 growing season Cuba recorded its highest-ever production levels for ten of the thirteen basic food items in the Cuban diet. The production increases

came primarily from small farms, and in the case of eggs and pork, from booming backyard production. The proliferation of urban farmers who produce fresh produce has also been extremely important to the Cuban food supply. The earlier food shortages and the rise in food prices suddenly turned urban agriculture into a very profitable activity for Cubans, and once the government threw its full support behind a nascent urban gardening movement, it exploded to near epic proportions.

Formerly vacant lots and backyards in all Cuban cities now sport food crops and farm animals, and fresh produce is soldfrom private stands throughout urban areas at prices substantially below those prevailing in the farmers markets. There can be no doubt that urban farming, relying almost exclusively on organic techniques, has played a key role in assuring the food security of Cuban families over the past two to three years.

An Alternative Paradigm?
To what extent can we see the outlines of an alternative food system paradigm in this Cuban experience? Or is Cuba just such a unique case in every way that we cannot generalize its experiences into lessons for other countries?

The first thing to point out is that contemporary Cuba turned conventional wisdom completely on its head. We are told that small countries cannot feed themselves, that they need imports to cover the deficiency of their local agriculture. Yet Cuba has taken enormous strides toward self-reliance since it lost its key trade relations.

We hear that a country can't feed its people without synthetic farm chemicals, yet Cuba is virtually doing so. We are told that we need the efficiency of large-scale corporate or state farms in order to produce enough food, yet we find small farmers and gardeners in the vanguard of Cuba's recovery from a food crisis. In fact, in the absence of subsidized machines and imported chemicals, small farms are more efficient than very large production units. We hear time and again that international food aid is the answer to food shortages—yet Cuba has found an alternative in local production.

Abstracting from that experience, the elements of an alternative paradigm might therefore be:
· Agroecological technology instead of chemicals: Cuba has used intercropping, locally produced biopesticdes, compost, and other alternatives to synthetic pesticides and fertilizers.

· Fair Prices for Farmers: Cuban farmers stepped up production in response to higher crop prices. Farmers everywhere lack incentive to produce when prices are kept artificially low, as they often are. Yet when given an incentive, they produce, regardless of the conditions under

which that production must take place.

· Redistribution of Land: Small farmers and gardeners have been the most productive of Cuban producers under low-input conditions. Indeed, smaller farms worldwide produce much more per unit area than do large farms. In Cuba redistribution was relatively easy to accomplish because the major part of the land reform had already occurred, in the sense that there were no landlords to resist further change.

· Greater Emphasis on Local Production: People should not have to depend on the vagaries of prices in the world economy, long distance transportation, and super power "goodwill" for their next meal. Locally and regionally produced food offers greater security, as well as synergistic linkages to promote local economic development. Furthermore such production is more ecologically sound, as the energy spent on international transport is wasteful and environmentally unsustainable. By promoting urban farming, cities and their surrounding areas can be made virtually self-sufficient in perishable foods, be beautified, and have greater employment opportunities. Cuba gives us a hint of the underexploited potential of urban farming.

Cuba in its Special Period has clearly been in a unique situation with respect to not being able to use power machinery in the fields, forcing them to seek alternatives such as animal traction. It is unlikely that either Cuba or any other country at its stage of development would choose to abandon machine agriculture to this extent unless compelled to do so. Yet there are important lessons here for countries struggling to develop.

Relatively small-scale farming, even using animals for traction, can be very productive per unit of land, given technical support. And it is next to impossible to have ecologically sound farming at an extremely large scale.

Although it is undeniable that for countries wishing to develop industry and at the same time grow most of their own food, some mechanization of agriculture will be needed, it is crucial to recognize—and the Cuban example can help us to understand this–that modest-sized family farms and cooperatives that use reasonably sized equipment can follow ecologically sound practices and have increased labor productivity.

The Cuban experience illustrates that we can feed a nation's population well with a small- or medium-sized farm model based on appropriate ecological technology, and in doing so we can become more self-reliant in food production. Farmers must receive higher returns for their produce, and when they do they will be encouraged to produce. Capital intensive chemical inputs—most of which are unnecessary—be largely dispensed with. The important

lessons from Cuba that we can apply elsewhere, then, are agroecology, fair prices, land reform, and local production, including urban agriculture.

Source: Peter M. Rosset is co-director of Food First/The Institute for Food and Development Policy . He has a Ph.D. in agricultural ecology and teaches at Stanford University.

For more information on Cuban agriculture, see Peter Rosset's new book, 'Sustainable Agriculture and Resistance: Transforming Cuban Food production,' at http://www.foodfirst.org/cuba/

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Kicking the chemical habit

Peter Rosset extols the virtues of the small farm model.

'With dependence on pesticides we have focused on the obvious problem, getting rid of pests, without looking at the deeper problem – a farming system out of balance,' says Paul Buxman. The California farmer, who grows peaches on his family farm in the San JoaquinValley, hasn't used pesticides since 1982. That's when a rash of cancers among local farm families, including his own, forced him to take a hard look at the way he farmed. Eventually, he abandoned pesticide use altogether. But despite that he still farms successfully today.

Buxman's case and many others like his give the lie to the agribusiness myths that pesticides are indispensable or that large farms are somehow more productive than small farms.

If a small-farm model of rural development makes more sense than the mechanized, chemical-intensive, corporate-dominated one toward which we are moving, then now is the time to recognize the genuine value of this fast-disappearing style of farming.

While large, industrial-style farms impose a scorched-earth mentality on resource management – no trees, no wildlife, endless monocultures – small farmers are usually very effective stewards of natural resources and soil.

In the US, small farmers devote seventeen per cent of their area to woodlands compared with only five per cent on large farms. And they keep nearly twice as much of their land for 'soil improving uses' including cover crops and green manures.[1]

In the Third World, peasant farmers show a tremendous ability to prevent and even reverse land degradation, including soil erosion. Compared with the ecological wasteland of a modern plantation growing export crops, the small farm landscape contains a myriad of biodiversity. This often means lower levels of pest attack and less need for pesticides. Also because small farms are mostly family-run it means that family members know the land intimately and have a genuine commitment to maintaining both soil fertility and long-term sustainability. That's something generally not found on large farms owned by absentee investors.

Not surprisingly, pesticide use in the Third World is concentrated on export crops grown by large farmers, not on staple foods produced mostly by small ones. Over 90 per cent of all pesticides in West Africa are used on export plantations. In Latin America, 'entrepreneurial farmers' who grow most of the export crops use three-quarters of the pesticides, while small farmers use just 11 per cent.[2] Food producers are often the poorest farmers and simply cannot afford the cost. Since pesticides must be imported into most Third World countries they are more likely to be used on crops that earn the foreign exchange needed to pay for them.

But there is an alternative. It's one that involves creating a viable and productive small-farm agriculture based on land reform using the principles of 'agroecology'. That is the only model with the potential to end rural poverty, feed everyone and protect the environment and the productivity of the land for future generations.

From the United States to India alternative agriculture is slowly proving itself. But it's in Cuba where this alternative has been put to its greatest test.

Before 1989 Cuba was a model Green Revolution-style farm economy. Its success was based on enormous farms using vast quantities of imported chemicals and machinery to produce export crops while over half of the island's food was imported. The Government's commitment to equity as well as favorable terms of trade offered by Eastern Europe meant that Cubans were not undernourished. But the underlying vulnerability of this style of farming was exposed when the collapse of the Communist Bloc was added to the already existing, and soon to be tightened, US trade embargo.

When pesticides, chemical fertilizers and tractor parts could no longer be imported Cuba was plunged into the worst food crisis in its history. Within a few short months consumption of calories and protein dropped by as much as 30 per cent. Nevertheless, by 1997 Cubans were eating almost as well as they had before 1989. Yet comparatively little food or agrochemicals were being imported. What happened?

Faced with the impossibility of importing such inputs, Cuba turned inward to create a more self-reliant agriculture based on smaller farms, higher crop prices and agroecological technology.

The combination of food shortages and the opening of small markets meant that farmers began to receive much better prices for their products. Given this incentive farmers produced their crops even in the absence of pesticides. They were also given a huge boost by Government support for alternative methods and by the 'rediscovery' of traditional farming techniques.

Small farms consistently produce far more per hectare than large farms

Small farmers and co-operatives responded by increasing production while large-scale state farms stagnated and faced plunging yields. In response the Government began to divide up the state farms into small plots for sale to their former employees.

The Cuban experience shows that we can feed a nation's people using a small-farm model based on agroecological technology instead of pesticides – albeit in a small island nation of ten million people. And we can become more self-reliant in food production in the process. A key lesson is that when farmers receive fairer prices they produce – with or without chemical inputs. So if these expensive and noxious inputs are unnecessary, why not dispense with them altogether?

But how realistic is the idea that small farms could feed the world? We've all heard the counter arguments: large farms are more productive than small farms. We need to consolidate land holdings to take advantage of greater productivity and efficiency. But the actual data shows just the opposite – small farms consistently produce far more per hectare than large farms.

One reason for lower production levels on large farms is that they tend to be monocultures. The highest yield of a single crop is often obtained by planting it alone in a field. But while that may produce a lot of one crop, it generates nothing else of use to the farmer. In fact,

the bare ground between crop rows invites weed infestation. The weeds then make the farmer invest labor in weeding or money in herbicide.

Large farmers tend to plant monocultures because they are the simplest to manage with heavy machinery. Small farmers, especially in the Third World, are much more likely to plant crop mixtures (intercropping) where the empty space between the rows is occupied by other crops. They usually combine or rotate crops and livestock, with manure serving to replenish soil fertility.

Such integrated farming systems produce far more per unit area than do monocultures. The yield per unit area of one crop – corn for example – may be lower on a small farm than on a large monoculture. But the total production per unit area, often composed of more than a dozen crops and various animal products, can be far, far higher. This holds true whether we are talking about an industrial country like the US or any country in the developing world. Data on farm size and total production is available for 15 countries in the Third World. In all cases smaller farms are much more productive than larger ones – 200- to 1,000-per-cent more productive per unit area. In the US small farms with 11 hectares or less have more than 10 times greater dollar output per hectare than larger farms.[1]

In American communities which are dominated by large corporate farms, nearby towns have died off. Mechanization means that fewer local people are employed and absentee ownership means that farm families themselves are no longer needed.

In towns surrounded by family farms the income circulates among local businesses, generating jobs and community prosperity. Where family farms predominate there are more local businesses, paved streets and sidewalks, schools, parks, churches and clubs as well as better services, higher employment and greater civic participation.

We find similar local benefits with a small farm economy in the Third World. The Landless Workers Movement (MST) is a grassroots organization in Brazil that helps landless laborers to organize occupations of idle land belonging to wealthy landlords.

When the movement began in the mid-1980s, the mostly conservative mayors of rural towns were violently opposed to MST land occupations. However, in recent times their attitude has changed. Most of their towns are depressed economically and land occupations can give local economies a much-needed boost. Typically up to 3,000 families may invade a chunk of idle land and start to farm.

They sell their produce in the marketplaces of the local towns and buy their supplies from local merchants. Not surprisingly those towns with nearby MST settlements are now better off economically than other similar ones elsewhere and many mayors now actually petition the MST to carry out occupations near their towns. Today a small but growing movement within the MST is pushing for agroecological, pesticide-free farming techniques.

To the productive, economic and environmental benefits of small farm agriculture – including reduced pesticide use – we can add the continuance of cultural traditions and of the rural way of life. It seems obvious that if we are truly concerned about rural peoples and ecosystems, then the preservation and promotion of small, family farm agriculture is a vital step forward.

PAUL SMITH / PANOS

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1 *The Multiple Functions and Benefits of Small Farm Agriculture In the Context of Global Trade Negotiations,* Peter Rosset, Institute for Food and Development Studies, Food First Policy Brief No 4, 1999, on-line at http://www.foodfirst.org/media/press/1999/smfarmsp.html

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Genetic Diversity and Disease Control in Rice

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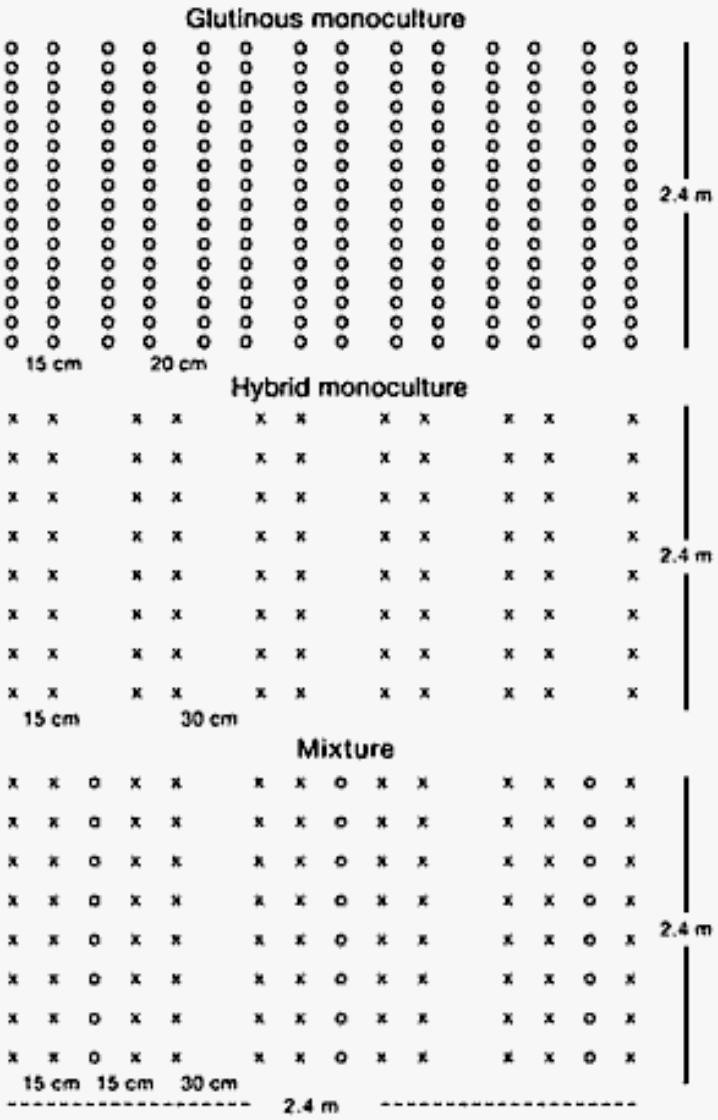
Crop heterogeneity is a possible solution to the vulnerability of monocultured crops to disease1-3. Both theory4 and observation2, 3 indicate that genetic heterogeneity provides greater disease suppression when used over large areas, though experimental data are lacking. Here we report a unique cooperation among farmers, researchers and extension personnel in Yunnan Province, China—genetically diversified rice crops were planted in all the rice fields in five townships in 1998 and ten townships in 1999. Control plots of monocultured crops allowed us to calculate the effect of diversity on the severity of rice blast, the major disease of rice5. Disease-susceptible rice varieties planted in mixtures with resistant varieties had 89% greater yield and blast was 94% less severe than when they were grown in monoculture. The experiment was so successful that fungicidal sprays were no longer applied by the end of the two-year programme. Our results support the view that intraspecific crop diversification provides an ecological approach to disease control that can be highly effective over a large area and contribute to the sustainability of crop production.Many ecological processes are strongly influenced by spatial scale6-9, causing a major dilemma for experimental biologists, as large-scale field experiments are often prohibitively expensive. For example, there have been increasing calls for ecological approaches to counter the negative environmental impacts of modern agricultural systems10, 11. One such approach, the use of within-field crop genetic diversity, has been shown to reduce disease severity in experimental plots and has been used commercially in some cases1-4. However, experimental procedure and the nature of pathogen dispersal can cause substantial underestimation of the impact of increased diversity on disease in small-scale experimental plots2-4. On the other hand, observations at larger spatial scale are few4, and do not allow for unambiguous determination of causal relationships between diversity and disease occurrence.

Our experimental system was blast disease in rice (Oryzae sativa). Rice is the staple crop for about half of the population of the world12. The fungus that causes blast disease, Magnaporthe grisea, spreads through multiple cycles of asexual conidiospore production during the cropping season, causing necrotic spots on leaves and necrosis of panicles. M. grisea interacts on a gene-for-gene basis13, 14 with its host and has a very varied pathogenesis15. It exists as a mixture of pathogenic races, that is, genetic variants that attack host genotypes with different resistance genes. Thus, host resistance genes often remain effective for only a few years in agricultural production before succumbing to new pathogenic races16, 17.

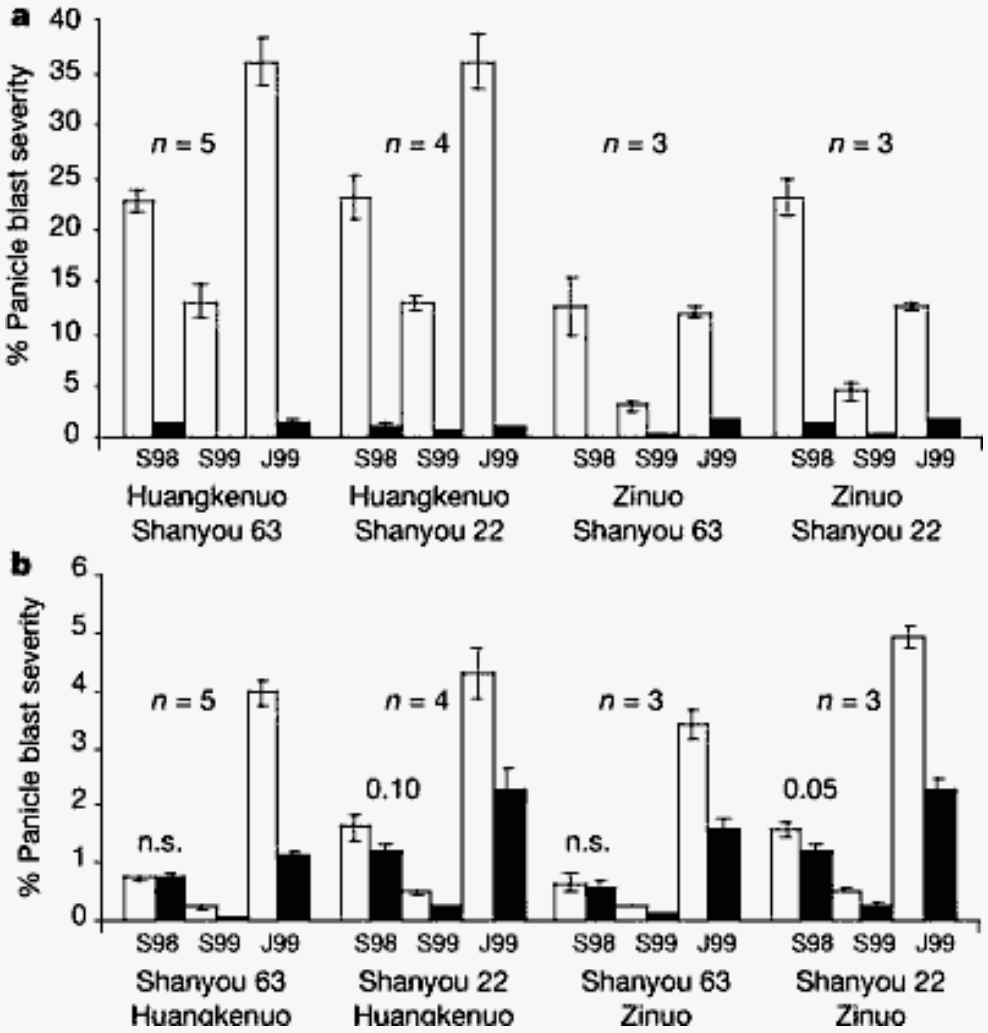
Our experimental site (Yunnan Province, China) favours the development of rice blast epidemics because of its cool, wet climate. Farmers commonly make multiple foliar fungicide applications to control blast. Glutinous or 'sticky' rice varieties are used for confections and other speciality dishes and have higher market value than other rice types, but have lower yields and are highly susceptible to blast. Non-glutinous, hybrid rice varieties are less susceptible to rice blast and are attacked by a different spectrum of M. grisea races. Before 1998, 98% of rice fields in the study area were sown with monocultures of the hybrid rice varieties Shanyuo22 and Shanyuo63. The desirable glutinous varieties were planted in small amounts because of their low yields and vulnerability to blast in this environment. We conducted large-scale tests, made possible through the cooperation of thousands of rice farmers, to determine how the occurrence of rice blast is affected by within-field varietal diversification using mixtures of commonly grown glutinous and hybrid rice varieties. Our approach was based on an observed farmer practice of dispersing single rows of glutinous rice between groups of four rows of hybrid rice at a rate sufficient to meet local demand for glutinous rice (Fig. 1).

Figure 1 Planting arrangements in rice variety mixture and monoculture survey plots in 1999 and patterned after those used by farmers in Yunnan Province. Each symbol represents a hill of susceptible (O) or resistant (X) rice. Distances between hills within rows were 15 cm for glutinous monocultures, 30 cm for hybrid monocultures and 30 cm for mixtures. Spacings and arrangements were the same in 1998, except that the distance between rows of glutinous rice in monoculture was 13 cm.



In the first year of the experiment, four different mixtures of varieties (Fig. 2) were planted in a 812-ha area consisting of all rice fields in five townships of Shiping County, Yunnan Province. Because of the excellent blast control provided by the variety mixtures, only one foliar fungicide spray was applied. Mixtures were compared to monoculture control plots at 15 survey sites. Unlike standard experiment station fields, control plots of monocultures were small relative to the total area of mixtures planted by farmers in the surrounding area, reducing the potential impact of spore dispersal from the more heavily infected monocultures to the mixture plots2-4. The study was expanded to 3,342 ha of rice fields in 1999. This area consisted of all rice fields in 10 townships that spanned Jianshui and Shiping Counties, with five participating townships and 15 survey sites per county. Procedures were the same as in 1998, except that no foliar fungicide applications were made. In addition, some farmers chose to plant mixtures in a ratio of 1 glutinous: 6 hybrid rows, rather than 1:4.

Figure 2 Panicle blast severity (mean percentage of panicle branches that were necrotic due to infection by *Magnaporthe grisea*) of rice varieties planted in monocultures and mixtures. **a**, The susceptible, glutinous varieties Huangkenuo and Zinuo. **b**, The resistant, hybrid varieties Shanyuo22 and Shanyuo63. S98, Shiping County, 1998; S99, Shiping County, 1999; J99, Jianshui County, 1999; open bar, blast severity for a variety grown in monoculture control plots; black bar, blast severity of the same variety when grown in mixed culture plots in the same fields. Error bars are one s.e.m.; *n*, number of plot means that contribute to individual bars for each of the four combinations of susceptible and resistant variety. All differences between pairs of monoculture and mixture bars are significant at $P < 0.01$ based on a one-tailed *t*-test, unless indicated by 0.05 (significant at $P < 0.05$), 0.10 (significant at $P < 0.10$) or n.s. (not significant at $P = 0.10$).



Diversification had a substantial impact on rice blast severity (Fig. 2). In 1998, panicle blast severity on the glutinous varieties averaged 20% in monocultures, but was reduced to 1% when dispersed within the mixed populations (Fig. 2a). Panicle blast severity on the hybrid varieties averaged 1.2% in monoculture and was reduced to varying degrees in mixed plots, though only the larger differences were statistically significant (Fig. 2b). Results from 1999 were very similar to the 1998 season for panicle blast severity on the susceptible varieties (Fig. 2a), showing that the effect of diversification was very robust among mixtures and between seasons and counties. In contrast, effects of crop diversification on blast severity of the hybrid varieties were larger in 1999 than in 1998. Panicle blast severity on these varieties averaged 2.3% in monoculture and was reduced to 1.0% in mixed populations (Fig. 2b), despite the fact that hybrids were planted at the same density in both mixture and monoculture survey plots.

Several mechanisms may reduce disease severity in genetically diverse plant populations2, 4, 18. Increased distance between plant genotypes, which dilutes inoculum of a given pathogenic race as it is dispersed between compatible host varieties, has been considered the most important mechanism contributing to disease reduction in variety mixtures2. Such dilution effects almost certainly had a role in reducing blast disease on the susceptible, glutinous varieties in this study. In addition, canopy microclimate data collected at one survey site in 1999 indicate that height differences between the taller glutinous and shorter hybrid varieties resulted in temperature, humidity and light conditions that were less conducive for blast on glutinous varieties in the mixtures than in the monocultures. Disease reductions on hybrid varieties in the mixtures are more difficult to explain. Dilution and microenvironmental modifications are unlikely mechanisms, as the hybrids were planted at the same density in mixtures and monocultures (Fig. 1). The taller glutinous varieties may physically have blocked spore dispersal and/or altered wind patterns compared with the hybrid monocultures. In addition, induced resistance may have some contribution to disease suppression in the hybrids. Induced resistance occurs when inoculation with avirulent pathogen race(s) induces a plant defence response that is effective against pathogen races that would normally be virulent on that host genotype. This has made significant contributions to disease reductions in variety mixtures of other small grain crops19, 20.

In 1999, we determined the genetic composition of the pathogen populations derived from inter-planting and monoculture fields using polymerase chain reaction (PCR) fingerprinting21 of pathogen isolates. Preliminary results indicate that fields with mixtures supported diverse pathogen populations with no single dominant strain. In contrast, pathogen populations from monoculture fields were dominated by one or a few strains. The more diverse pathogen population from the mixed stands may have contributed to greater induced resistance from incompatible interactions. In the longer term, this increased pathogen diversity may also slow adaptation of the pathogen to resistance genes functioning within a given mixture. Clarifying the mechanisms by which host diversity influenced disease in our study will be helpful in extending these results to other agro-ecosystems. These mechanistic studies are currently underway.

Table 1 -Grain Yields and Monetary Values for Rice Varieties

		Grain yield ± s.e.m. (Mg per ha)			Crop value (US$ per ha)		
Variety or mixture	**Hills m-2,1**	**Shiping/ 98**	**Shiping/ 99**	**Jianshui/ 99**	**Shiping/ 98**	**Shiping/ 99**	**Jianshui/ 99**
Huangkenuo	38.1	3.69±0.02	4.07±0.07	5.12±0.05	1291	1424	1794
Shanyuo63	14.8	8.14±0.07	8.41±0.12	9.71±0.07	1709	1765	2039
Mixture	18.5	8.72±0.05	9.53±0.11	10.53±0.12	1912	2166	2341
Huangkenuo	3.7	0.59(173)	1.19(300)	0.92(186)	205	415	323
Shanyuo63	14.8	8.13(100)	8.34(99)	9.61(99)	1707	1751	2018
Huangkenuo	38.1	3.79±0.03	4.15±0.07	5.08±0.10	1328	1452	1778
Shanyuo22	14.8	7.97±0.11	8.12±0.06	9.08±0.20	1673	1705	1907

Mixture	18.5	8.40±0.12	8.77±0.09	10.00±0.16	1838	1941	2231
Huangkenuo	3.7	0.53(151)	0.71(177)	0.94(191)	184	249	330
Shanyuo22	14.8	7.88(99)	8.06(99)	9.05(100)	1654	1692	1901
Znuo	38.1	3.62±0.04	3.97±0.02	4.90±0.09	1268	1390	1716
Shanyuo63	14.8	8.28±0.13	8.40±0.08	9.63±0.17	1739	1765	2022
Mixture	18.5	8.90±0.22	9.23±0.03	10.46±0.18	1937	2056	2315
Znuo	3.7	0.48(146)	0.84(217)	0.84(177)	170	294	296
Shanyuo63	14.8	8.42(102)	8.39(100)	9.62(100)	1767	1762	2020
Znuo	38.1	3.49±0.02	3.82±0.03	4.89±0.11	1220	1337	1711
Shanyuo22	14.8	7.84±0.06	8.14±0.03	9.14±0.05	1646	1710	1919
Mixture	18.5	8.27±0.05	8.86±0.07	9.99±0.03	1807	1965	2227
Znuo	3.7	0.51(160)	0.75(203)	0.92(193)	178	264	321
Shanyuo22	14.8	7.76(99)	8.10(99)	9.08(99)	1629	1701	1906

The rice varieties were grown as monocultures or mixed in Shiping and Jianshui counties in 1998 and 1999. Crop values based on market prices of 0.21 US$ per kg for hybrid varieties and 0.35 US$ per kg for glutinous varieties. Italicized values of hills m^{-2}, grain yield, and crop value are for individual varieties within mixtures. Bold values in parentheses are per- hill yields of varieties in mixture expresses as a percentage of per-hill yield of the saem variety in monoculture.
* See also Fig.1
§ In 1998, density of glutinous varieties in monoculture was 40.4 hill m^{-2}

Grain production per hill of glutinous varieties in mixtures averaged 89% greater than that in monoculture (Table 1). As a result, glutinous rice in mixtures produced 18.2% of monoculture yield, on average, though it was planted at rates of only 9.2 and 9.7% that of monoculture in 1998 and 1999, respectively (see also Fig. 1). Reduced disease severity certainly had a role in this yield response, though other factors (for example, improved light interception) may also have had an influence. Despite the increased overall plant density in mixtures (see Fig. 1, bottom), grain yields per hectare of the hybrids in mixture were nearly equal to the corresponding monocultures. Thus, mixed populations produced more total grain per hectare than their corresponding monocultures in all cases (Table 1). Land equivalent ratios22, which estimate the ecological efficiency of mixed populations, indicate that an average of 1.18 ha of monoculture crop land would need to be planted to provide the same amounts of hybrid and glutinous rice as were produced in 1 ha of a mixture (Table 2). After accounting for the differing market values of the two rice types, the gross value per hectare of the mixtures was 14% greater than hybrid monocultures and 40% greater than glutinous monocultures (Table 1).

Table 2 - Land Equivalent Ratios for Rice Yield Produced in Variety Mixtures

	County and year		
Mixture	**Shipping 1998**	**Shipping 1999**	**Jianshui 1999**
Huangkenuo/Shanyuo63	116	128	117
Huangkenuo/Shanyuo22	113	116	118
Zinuo/Shanyuo63	115	121	117
Zinuo/Shayuo22	114	119	118

Though disease reductions are theoretically maximized in random mixtures of plants23, row mixtures provided the most practical approach in our specific application. As rice is hand-harvested in Yunnan Province, farmers can easily separate the hybrid and glutinous grains, which are used for different purposes. However, many other approaches can be used to attain within-field genetic diversity of crops3, 24. For example, wheat (Triticum aestivum) mixtures are grown in the Pacific Northwest of the USA under highly mechanized conditions4. In this case, varieties are chosen to be similar in height, maturity and market

quality, planted as random mixtures, and harvested and marketed as bulk populations3.

Commercial-scale use of crop diversity has provided observational support for the disease-suppressive effects of crop diversity in a limited number of cases4, 25, 26, most notably the control of barley (Hordeum vulgare) powdery mildew (caused by Erysiphe graminis) in the former East Germany26. However, the varietal diversification program in Yunnan Province provided an unusual opportunity to determine causal relationships between crop diversity and disease, as replicated monoculture controls were available for comparison within a substantial expanse of mixed culture. The impact of crop diversification on blast severity in this study was greater than that reported from small-scale experimental plots with this disease3, although we do not have proof that this difference is due only to the spatial scale. By the second year of the project, no foliar fungicides were needed for blast control in the diversified area, though this may not be possible in all seasons. The Yunnan diversification program has resulted in great interest by farmers, and the practice has expanded to more than 40,000 ha in 2000.

The 'Green Revolution' has provided remarkable increases in crop productivity over the past four decades27. However, this agricultural transformation has also resulted in problems, including loss of crop genetic diversity11. The current world population of over six billion does not allow us to return to agricultural production practices of the past. Rather, we need to maintain the benefits of modern agriculture while addressing its drawbacks. In this regard, it is significant that the diversification program described here is being conducted in a cropping system with grain yields approaching 10 Mg ha^{-1}, among the highest in the world. The value of diversity for disease control is well established experimentally and diversity is increasingly being used against wind-dispersed pathogens of small grain cereals4. Recent experimental results indicate other applications of diversity, for example, against soil-borne pathogens and for tree crops4. The effect of varietal diversification will vary among diseases and agro-ecosystems4. Further, one can not expect all variety mixtures to provide functional diversity to a given plant pathogen population24, 28, nor can one predict the time for which they may remain effective. Indeed, we have identified variety combinations that provide little or no blast control in Yunnan Province. Nonetheless, our results demonstrate that a simple, ecological approach to disease control can be used effectively at large spatial scale to attain environmentally sound disease control.

Methods

Study sites In 1998, townships participating in the diversification experiment were Baxing, Baoxiu, Songchun, Maohe and Xincheng of Shiping County. These townships are contiguous, and all rice fields in the five townships were involved in the diversification program. In 1999, the study area consisted of all rice fields in ten contiguous townships: Chenguang, Dongba, Mianding, Nanzhuang and Xizhuang in Jianshui County; and Baxing, Baoxiu, Songchun, Maohe and Yafanzi in Shiping County.

Disease assessments

To monitor disease, survey plots were established at 15 sites per county, three in each of the five townships participating in the diversification program (15 sites in 1998, 30 sites in 1999). Seedlings were transplanted into the field in April or May in hills of 4–5 plants for glutinous varieties and 1 plant per hill for the hybrid varieties, which produce a greater number of tillers per plant. All plots were managed by farmers and treated in the same manner as the surrounding mixed variety plantings, including fungicide application. In each of the survey sites, a field was divided into three plots. One plot was planted with the mixture grown most commonly by local farmers, and the remaining two plots were monocultures of the glutinous and hybrid variety included in that mixture. For mixtures, the same row spacing of hybrid rice was used as in monoculture, but one row of glutinous rice was added between each group of four rows of hybrid rice, in an 'addition' approach (Fig. 1). Each of the four mixtures was evaluated for disease severity in 3–5 of the 15 survey sites in each county, depending on the popularity of a given mixture with farmers. Plots ranged from 100 to 450 m 2 each, depending on field size.

Survey plots were assessed in late August for the severity of blast symptoms, expressed as the percentage of panicle branches that were necrotic due to the effects of M. grisea. Disease was assessed at five sampling points in each plot, distributed in a uniform pattern. Twenty hills resulting from the transplanting process were evaluated at each sampling point, with each hill containing about 10 panicles per hill, to give a total of approximately 1,000 panicles evaluated per plot. Each sampled panicle was visually examined by experienced personnel to estimate the percentage of branches that were necrotic due to infection by M. grisea. Each panicle was given a rating29 from 0 to 5, where 0 is no disease; 1 is less than 5% of panicle branches necrotic; 2 is 5–30% necrotic; 3 is 30–50% necrotic; 4 is greater than 50% necrotic; and 5 is 100% necrotic. Disease severity was summarized within each plot as $([(n_1 \times 1) \pm (n_2 \times 2) \pm (n_3 \times 3) \pm (n_4 \times 4) \pm (n_5 \times 5)]/\Sigma n0... n5\} \times 100$, where $n_0 ... n_5$ is the number of culms in each of the respective disease categories. Thus, a disease severity of 0% would indicate no disease and 100% would indicate that 100% of panicle branches were necrotic.

Yield evaluation Plots were hand-harvested, threshed and weighed to determine grain yield. Individual varieties were evaluated separately in mixtures. Land equivalent ratios22 were calculated as (yield ha^{-1} of variety A in mixture/yield $ha^{-1}$of variety A in monoculture) + (yield ha^{-1} of variety B in mixture/yield ha^{-1} of variety B in monoculture).

Statistical analyses Each survey plot was considered to be an experimental unit, and analyses were based on mean disease severities and grain yield for each plot. Statistical analyses were conducted separately by year and county owing to differences in disease level. One-tailed t -tests were used to determine if blast severity for each of the two varieties in each of the four mixtures differed significantly from its corresponding monoculture control.

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Madagascar rice trials lead to agricultural revolution: New methods break
with centuries of tradition.

When small farmers in Madagascar employed a new way of growing rice in the
late 1980s, the results were so startling that agricultural scientists
could hardly believe they were possible. Yields of about two tonnes per
hectare had shot up to about 8-10 tonnes per hectare, without chemical
fertilisers, pesticides or expensive seed varieties, and by breaking some
of the conventional "rules" of rice management. For years the new
technique, known as the System of Rice Intensification (SRI), was virtually
ignored. The system was developed in Madagascar by an agronomist priest,
Henri de Laudani, working with a small farmers group, Association Tefy
Saina.

Last week a representative of the group, Sebastin Rafaralahy, presented its
work to a conference in London, "Reducing Poverty though Sustainable
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Agriculture", organised by the University of Essex together with the Department for International Development.

Traditionally, rice is transplanted into fields at about eight weeks, said Mr Rafaralahy, when the plant is strong and likely to survive, and three or more seedlings are planted in clumps in the hope that one will fully mature. But with SRI, seedlings are transplanted at about six days and planted individually, enabling farmers to use less seed. For thousands of years lowland rice has been grown under flooded conditions to ensure water supply and reduce weed problems. But while rice can survive in water, it is not an aquatic plant, Mr Rafaralahy pointed out.

Farmers in Madagascar noted that root growth was far greater if the plant was not kept continually submerged in water - "the plants receive more oxygen and nutrients from the atmosphere and derive greater benefit from the warmth of the sun", he said. Using the SRI system the soil is only kept continually wet during the reproductive stage when the plant is producing grains. During the rest of the growth cycle the fields are irrigated in the evening and dry during the day. Using their own seed, some 20,000 farmers have now adopted the method in Madagascar, and the yields have proved sustainable.

After being evaluated by Cornell University in the US, the system has spread to other countries, including major rice growers such as Bangladesh, China and Indonesia. In China yields of 9-10.5 tonnes per hectare were achieved in the first year of the system, compared with the national average of 6 tonnes per hectare. This initiative in Madagascar was one of a number presented to the conference, all of which are included in a database of sustainable agriculture projects built up by professor Jules Pretty of the University of Essex.

He told the conference that the database now contains information on 208 initiatives from 52 countries, which indicates that at least 9m farmers have adopted sustainable agriculture methods on 29m hectares of land - some 3 per cent of land under crops in Africa, Asia and Latin America. Sustainable agriculture makes the best use of "nature's goods and services to help with pest control, soil regeneration and nutrient cycling", said professor Pretty; "and better use of the knowledge and skills of farmers, so improving their self-reliance".

Modern agriculture, he believes, is "very successful in terms of food production but causes a lot of damage to the environment and has tended to damage the natural processes". The evidence, he said, shows that switching to sustainable agriculture "can lead to substantial increases in per hectare food production".

For non-irrigated crops, yields typically increase by 50-100 per cent "though considerably greater in a few cases. For 146,000 farmers cultivating roots - potato, sweet potato and cassava - average food production increased by 150 per cent". For irrigated crops, the gains were much smaller, 5-10 per cent, "through starting from a higher absolute yield base".

With policy and institutional support, the benefits of sustainable agriculture could spread to much larger numbers of people, believes professor Pretty, but he cautions that "even the substantial increase reported here might not be enough". "We cannot yet say that a transition to sustainable agriculture will result in enough food to meet the needs of developing countries, but there is scope for considerable confidence," he said.


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The SYSTEM of RICE INTENSIFICATION

known as SRI -- *le Systéme de Riziculture Intensive* in French and *la Sistema Intensivo de Cultivo Arrocero* (SICA) in Spanish -- is a methodology for increasing the productivity of irrigated rice by changing the **management of plants, soil, water and nutrients**. These practices contribute to both healthier soil and plants supported by greater root growth and the nurturing of soil microbial abundance and diversity. It is based on a number of agroecological principles with good scientific foundations. SRI concepts and practices have also been successfully adapted to upland rice.

SRI *does not require* the purchase of new seeds or the use of new high-yielding varieties, although some of the highest yields with SRI have been obtained from improved varieties. Neither does SRI require the application of cehmical fertilizer or pesticides. Increased weeding is required, because rice fields are not kept continuously flooded. But farmers report that with SRI methods, their rice plants are better able to resist damage from pests and diseases, making agrochemicals usually unnecessary. Compost gives even better results than does fertilizer with SRI methods. With SRI there can be **water savings** of around 50%.

SRI *does require* **skillful management** of the factors of production and, at least initially, additional **labor input** -- between 25 and 50%, particularly for careful transplanting and for weeding. But since **yield increases** are 50 to 100%, and possibly by two or three times present levels, **returns to labor** are very great since no purchased inputs are needed and **profitability** of rice production is increased. As farmers gain skill and confidence in SRI methods, labor input decreases and can eventually become the same or even less compared with conventional rice-growing methods.

Improvements in SRI are continually being made, including better implements and techniques, which farmers are encouraged to consider and further improve upon.

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QUESTIONS AND ANSWERS ABOUT THE SYSTEM OF RICE INTENSIFICATION (SRI) FOR RAISING THE PRODUCTIVITY OF LAND, LABOR AND WATER

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The System of Rice Intensification (SRI), called the *Système de Riziculture Intensive* in French, was developed through the work of Fr. Henri de Laulanié, S.J., who lived in Madagascar from 1961 until his death in 1995. Having been trained in agriculture at the National School of Agriculture (ENA) in France before World War II, he brought a basic knowledge of agricultural science to the task of raising rice production, but most of what he learned about rice was learned from working closely with farmers and from observing rice plants very closely. He regarded the rice plant as his teacher, "*mon maitre*" (Laulanié 1993).

SRI has been written about elsewhere (Rabenandrasana 1999; Uphoff 1999; Uphoff 2002; Stoop et al. 2002). What is undertaken here is to link what has been learned about SRI from observations and measurements to what can be found in the scientific literature. Most of the answers remain to be validated by more systematic scientific investigation. Thus, the answers here should be regarded as provisional, presented with the hope that this account will prompt scientists who are in a better position than the author (a social scientist by training) to demonstrate agronomic relationships to the satisfaction of agricultural scientists. There are now enough reports of SRI methods raising yields significantly in many countries around the world, at least a dozen in Asia, Africa and Latin America, that the challenge is to understand how the set of changes in managing plants, soil, water and nutrients can achieve such great advances in factor productivity.

1. *What **yields** are obtainable with SRI methods?*

Association Tefy Saina (ATS), the Madagascar NGO most actively promoting them, has found that yields *of any rice variety* can be at least doubled, and often yields can be increased by considerably more than this with SRI methods. In the area around Ranomafana National Park on the edge of primary rain forest in the eastern part of the country, where average yields for irrigated rice using traditional methods are about 2 t/ha, farmer using SRI methods between 1993/94 and 1998/99 averaged over 8 t/ha. During this time, the number of farmers working with Tefy Saina to learn SRI, increased from just 38, using these methods on 5.7 hectares, to 396 using them on 50.6 hectares. In addition, many other farmers were informally or partially using the methods (data from Association Tefy Saina, Antananarivo).

During the same five-year period, hundreds of farmers on the high central plateau around Antsirabe and Ambositra (over 1,000 m) averaged 7.91 to 9.18 t/ha with SRI methods, compared to 3.95 to 4.23 t/ha with the more costly methods of production recommended by government agents, and 2.24 to 2.47 with peasant practices. The area cultivated with SRI methods increased during this time from 34 to 543 hectares (Hirsch 2000).

Similar yield increases have been recorded with SRI methods elsewhere in Madagascar. A comparative study in 1995/96 with 108 farmers on the high plateau, who were using these methods for the first time, found their average yields around the capital Antananarivo increased

from 3.2 to 6.3 t/ha, and from 3.9 to 8.0 t/ha around Antsirabe (MARD/ATS 1996). In the north near Andapa, a private company (SOAMA) reported that farmers using HYVs and "optimum" fertilizer applications had reached 6.2 t/ha, while 27 farmers in the same area who used SRI methods got 10.2 t/ha. (Four farmers who used IR-46 averaged 13.7 t/ha.) Around Marovoay in the northwest, another company (FIFABE) reported yields of 4.8 t/ha with "modern" practices including fertilizer, while farmers there who were practicing SRI it said got 7.1 t/ha. (These data are from the proceedings of a 1996 World Bank symposium on rice in Madagascar.)

Some farmers around Ranomafana who used SRI techniques most effectively have gotten yields around 14 to 16 t/ha. Some farmers in the Fianarantsoa region have attained even higher yields. In May 1999, the author together with Bruno Andrianaivo, an IRRI-trained rice agronomist who is a research staff member for FoFiFa, the agricultural research agency of the government, visited a farmer (Ralalason) who had just harvested 2,740 kg of rice from his small holding, 13 ares of land (1/8 hectare) near Soatanana. This represents a yield of 21 t/ha, ten times the national average. The farmer was in his sixth year using SRI techniques and had mastered them very well. His super-yield was made possible by the application of large amounts of well-made compost (we estimated a rate of about 40 t/ha), not to the rice crop but to the preceding inter-season crop of potatoes.

Increased yields with SRI have been attained at altitudes ranging from almost sea level to over 1,200 m, and on quite a range of soils, though the best yields require well-drained soils. They do not require particularly fertile soils, as most of the soils in Madagascar are very poor, and those around Ranomafana have been characterized, based on systematic soil analyses, as some of the poorest is the world (Johnson 1994).

There is increasing confirmation of higher yields now coming from other countries. The Agronomy Department at Nanjing Agricultural University in China did SRI trials with different spacing (20x20cm to 30x30cm) in 1999 and got 9.2 to 10.5 t/ha, the latter being with the wider spacing. The Agency for Agricultural Research and Development in Indonesia, at its Sukamandi rice research station, got 6.2-6.8 t/ha in its first trials (dry season 1999) and 9.5 t/ha in the second trial (wet season 1999-2000).

NGOs in the Philippines (CDSMC and BIND) and Cambodia (CEDAC) working with small farmers in these countries have recorded more than doubled yields, to 5 and 6 t/ha respectively, in their first year of using SRI methods. Farmers are very keen to continue with SRI because of the way the plants grow, with resistance to pests and diseases, so those evaluations are expanding. Farmers in Bangladesh working with CARE and the Department of Agricultural Extension have gotten 6.5-7.5 t/ha, and in Sri Lanka, farmer yields have averaged over 8 t/ha, reaching as high as 16 t/ha. The first two yields reported from Cuba using SRI methods were both over 9 t/ha, and trials in 2000 at the National Agricultural Research Center at Sapu in The Gambia in West Africa ranged from 5.4 to 8.4 t/ha. So the Madagascar experience is not a fluke.

2. *What **inputs** are needed to achieve these yield increases?*
No purchased inputs -- only additional labor, and particular skill and care in managing plants, soil, water and nutrients together. SRI does not require new seeds or high-yielding varieties, though some HYVs have responded very well to SRI management practices. FoFiFa in a 1989

extension bulletin announced that its variety 2067 (descended from Tainung 16) averages 5.6 t/ha, with a "maximum observed yield" of 7.7 t/ha. Yet farmers using 2067 with SRI practices around Ranomafana averaged about 11 t/ha in 1997-98, and one exceptional farmer in Soatanana reported above, who planted variety 2067, reached 21 t/ha in the 1998-99 season. We also noted above that four farmers who had used IR-46 in 1995-96 averaged 13.7 t/ha near Andapa.

So far, all rice varieties have responded positively to SRI practices. While chemical fertilizer can be used with good effect, the best results have been obtained with composted biomass. Factorial trials have showed compost giving higher yields ceteris paribus, though the difference is small with HYVs, which have been selected for their responsiveness to NKP fertilizer. Research should be done on differences in varietal response to SRI management, and on the relative merits of supplementing soil nutrients with organic vs. inorganic forms, using compost vs. applying fertilizer.

Many farmers have gotten these much-increased yields without any nutrient amendments to their soil, simply by using the other SRI practices. This is surprising. Rice plants with SRI appear better able to utilize available nutrients in the soil, as discussed below. Field research done for a NC State University doctoral thesis (Johnson 1994) evaluated the soils around Ranomafana as some of the poorest in the world, e.g., having only 3-4 ppm of phosphorus, and with low to very low cation exchange capacity in all horizons. With very high yields coming off such poor soils, some enhancement or replenishment of nutrients will probably become advisable with SRI at least in the future. However, the impressive response of rice to SRI practices suggests that some fairly basic research on plant nutrient requirements and dynamics should be undertaken to understand how these high yields are possible on such nutrient-deficient soils.

*3. What **practices** make these higher yields possible?*

SRI changes four practices that farmers planting irrigated rice have used for centuries, even millennia. They modify conventional plant-soil-water-nutrient management for rice in the following ways. With SRI:

1. Instead of planting *fairly mature seedlings*, 3-4 weeks old or older, with SRI one plants **very young seedlings**, just 8-12 days old, when the plant has put out just two small leaves, and the root is still very simple, with the seed still attached. If the transplanting is done carefully, as discussed below, there is *less trauma* to the plant and it recovers from the shock of transplanting more quickly than at a later stage in its development. This preserves the plant's potential for ***much greater tillering*** -- 30 to 80 tillers per plant, and possibly 100 or more -- as well as for more root growth and grain filling provided that the other SRI practices are used concurrently to help plants realize this potential.

2. Instead of planting seedlings in *clumps of 3-4 plants* and sometimes more, with SRI one plants **single seedlings**. This means that there will be no competition between and among the roots of multiple seedlings. Intra-species competition is not more beneficial for plant growth than inter-species competition, e.g., with weeds. The result is ***much greater root development,*** provided there is ***careful planting*** as discussed below.

3. Instead of planting seedlings fairly *densely*, seedlings are **widely spaced**. This leads to ***enhanced root development*** which supports more yield because tillering and grain filling are greatly increased with the wider spacing between plants. Clearly one needs to *optimize, rather than maximize* spacing, since the objective is yield per unit of land and other resources, not per plant. With SRI, however, "less produces more."

   With SRI, seedlings are planted **in a square pattern**, rather than *in rows*. This gives wider spacing and facilitates mechanical weeding. Optimum spacing depends on soil and other conditions, so it needs to be determined empirically for specific field conditions. But with SRI, it is reasonable to start with 25 x 25 cm spacing and to increase, or decrease, this spacing experimentally. Some of the highest yields have come with 50 x 50 cm spacing (just 4 plants per square meter), when soil quality has been built up.

   With SRI, the **seeding rate** is much lower. The 1995-96 study of SRI performance on the high plateau noted above showed doubled yields with an average seed rate of *only 7 kg/ha*, compared to the rate of 107 kg/ha with farmers' usual methods. Farmers gained 100 kg of rice per hectare just from the lower seeding rate with SRI.[1]

4. Instead of keeping rice fields *flooded throughout the growing season*, as has been considered necessary to get best yields, **fields are kept moist but never flooded** during the vegetative growth phase with SRI. The soil is "lightly irrigated," with intermittent applications of water, and *never saturated*. We observe that the plants grow better if the field is, from time to time, allowed to dry out for several days, to the point of surface cracking, to contribute to aeration of the root zone. During the ensuing reproductive phase, a thin layer of water (1-2 cm) is kept on the field. These recommendations are purely empirical.

   No systematic research has been done on what are the **optimal water management practices** in conjunction with other SRI practices. This will be very important knowledge to gain. We have observed some farmers in Madagascar changing the water management regime with SRI to an alternating pattern with paddies flooded for 3 days and then drained and dried for 3-4 days. The objective is to keep rice roots from being suffocated by continuous flooded conditions.

   Reducing water requirements for rice could be a major contribution to agriculture in the 21st century. SRI's water management regime is hard for people to accept because it has been believed for ages that "rice is an aquatic plant." But while rice can *survive* under flooded conditions, we observe that it does not *thrive* under such conditions. Flooding creates anaerobic soil conditions, which subject rice roots to hypoxia (oxygen starvation).

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[1] A recent CIMMYT publication reports on a somewhat similar technology developed for wheat by farmers in Sonoroa, Mexico (Sayre and Moreno 1997). Farmers who used wide spacing on raised beds and furrow irrigation, instead of flood irrigation, reported that wheat yields did not change as the seeding rate was reduced from 200 kg/ha to 25 kg/ha. Possibly with some other changes in management practices, the yield level could have been increased as seen with SRI methods.

It has long been known that rice roots when growing under flooded conditions "senesce," i.e., die back, by the time the plant reaches the flowering stage (panicle initiation). But this has been assumed to be "natural," with no questioning or evaluation of whether or not these conditions are beneficial for rice plants. An exception is research by Ramasamy et al. (1997).

When Indian scientists (Kar et al. 1974) grew the same HYV (Taichung native cv) in both saturated and unsaturated soils, they found that by the onset of panicle initiation, from which time, grain formation and filling begins, ***78% of rice plant roots growing under flooded conditions had degenerated***. There was no degeneration of roots in well-drained soils. It is hard to imagine that such a massive loss of root capacity by the time when grain production starts would have no adverse effects on yield, but we have found no research demonstrating that what has been *assumed* is in fact correct.

Our own research shows ***much greater root development*** with SRI methods, which are grow rice under mostly aerobic conditions. The amount of force required to pull up a clump of *three* plants grown with conventional methods was 28 kg. This reflects the surface tension which the root system had with its surrounding soil. The force needed to uproot a *single* plant grown with SRI techniques was 53 kg -- *almost six times more force per plant* (Joelibarison 1998; this method for evaluating root development was validated by IRRI in the 1980s). Understanding the causes and effects of greater root growth in rice is an area where much systematic research is warranted but has been lacking.[2]

5. When rice is not grown under flooded conditions, weeds are likely to become a problem. With SRI, it is necessary to do **several weedings** -- at least 2 and preferably as many as 4 before panicle initiation. This is best (most quickly and beneficially) done with a simple, inexpensive mechanical hand push-weeder (rotating hoe), that was developed at IRRI in the 1960s and that churns up the soil with small, toothed wheels. No nutrients are lost to weeds as they are returned to the soil to decompose.

   This weeding method has the advantage apparently of *aerating the soil* to encourage greater root and canopy growth. Analysis of data for 76 farmers using SRI methods around Ambatovaky near Ranomafana in the 1997-98 season found that *each weeding beyond two added 1 to 2.5 t/ha to yield*. Similar increases had been observed the previous year for 40 farmers. Whether this effect is limited to the soil and other conditions around Ambatovaky is not known, but it should be assessed. The hypothesis that active soil aeration can enhance rice plant growth and performance is one of the most interesting propositions to emerge from work with SRI thus far. This merits systematic evaluation, since the cost for an additional weeding in Ambatovaky was about $25, with an associated increase in yield worth about $300-750.[3]

[2] There has been sadly little research done on rice roots. The most comprehensive and authoritative text on rice (DeDatta 1987) devoted only 8 lines out of 390 lines of text to any mention of roots in its chapter on the morphology, growth and development of the rice plant. Its index, with over 1,100 entries, has not a single entry on roots, and only one perfunctory reference to the rhizosphere. The author, who is a friend and colleague, explained this to me by saying that there was no research to report.

6. As discussed already, given the poor nutrient status of soils in most of Madagascar and the high yield levels resulting with SRI, some nutrient amendments should be normally part of the methodology. SRI was initially developed using chemical fertilizers, but drastic price increases in the late 1980s led to use of **compost**, which has contributed to the higher yields, sometimes to very substantially greater yields.

*4. Why were these practices **not discovered before**?*

Farmers have been growing paddy rice for thousands of years. One would expect that any practices which can exploit existing yield potentials of rice to the kind of levels reported here would have been discovered already. There are two main reasons why it took both diligence and serendipity to assemble the practices that constitute SRI. Both of these terms apply to Father de Laulanié, who developed the SRI methodology after and by working with Malagasy farmers for two decades.

1. Weeding and nutrient amendments are not controversial practices. It is the first four discussed above that are the core innovations of SRI. Each of these was unlikely to be discovered and adopted because **each seems to reduce the risk of crop failure**.

   Farmers in the past would have been reluctant to try these practices because they *look so risky*. (a) Planting large, mature seedlings seems like it should reduce the risk of plants dying after transplanting. (b) If several seedlings are planted together, at least some should survive. (c) Planting more plants is expected to give more yield, and (d) keeping an abundant supply of water in the field not only suppresses weeds (its main function), but also assures that the plants and soil will not dry out.

   SRI is *counterintuitive*, with "less" producing "more." Younger and fewer seedlings, grown in less water, produce more rice. Actually, we have not observed greater risk with SRI because its practices create a growing environment that is most suitable for rice plants. There is more labor and more management required; so the gains do not come free. But the returns to land and labor are increased enough to justify the greater effort.

2. If farmers tried any one of these SRI practices, the resulting yield improvement would be only a fraction of what can be produced with the full set of practices used together because of the **synergy** among them. There is an demonstrable ***positive feedback***

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[3] Yield levels associated with different numbers of mechanical weedings were as follow:

Weedings	N	Area (ha)	Harvest (kg)	Yield (t/ha)
None	2	.11	657	5.97
One	8	.62	3,741	7.72
Two	27	3.54	26,102	7.37
Three	24	5.21	47,516	9.12
Four	15	5.92	69,693	11.77

Bonlieu (1999) found additional weedings to add about 0.5 t/ha to yield under the poorer conditions around Morondava on the west coast of Madagascar. Even this lower increment was a cost-effective investment. The possible beneficial effects of active soil aeration are something that deserves further evaluation.

relationship between (a) greater root development and (b) greater tillering, and vice versa, and then when both contribute to (c) greater grain filling.

Transplanting young plants when other practices remain the same would not reveal the potential for more tillering. Spacing mature seedlings widely would give more root growth, but probably no increase in yield. Closely-spaced plants would not do well in well-drained fields because of their limited root growth. So, the whole *ensemble* of practices should be practiced together to get the remarkable results we see with SRI. If it is quite unlikely that the separate, apparently-risky practices would be experimented with, it is even less likely that the set of practices the constitute SRI would be tried out by farmers whose livelihoods depend on their rice production.

We would note that IRRI, in a communication responding to the papers and data on SRI that we submitted to it in early 1998, acknowledged that each of the SRI practices can enhance yield (it had no data on use of single seedlings, however). But it did not address the possibility of *multiplicative rather than additive* effects, which was supported by our data and suggested explanations.

*5. Has this hypothesized explanation of **synergy** been demonstrated?*

Yes. Students in the Faculty of Agriculture at the University of Antananarivo have conducted **factorial trials** that would assess the *respective and joint contributions* to yield that are made by the different practices that together constitute SRI. This is very complicated and demanding work, but Jean de Dieu Rajaonarison carried out factorial trials during the 2000 minor season on the west coast of Madagascar near Morondava. Andry Andriankaja then conducted trials in 2001 at Anjomakely, 18 km south of Antananarivo on the high plateau. Both studies were supervised by Prof. Robert Randriamiharisoa, director of research for the Faculty of Agriculture.

Both sets of trials tested six factors: age of seedling (16 or 20 days vs. 8 days), number of seedlings per hill (3 vs. 1), spacing (25x25 cm vs. 30x30 cm), water management regime (continuous flooding vs. controlled applications), fertilization (no fertilization as a control vs. NPK applications vs. compost), and either variety (HYV vs. local variety) or soil (good quality clay soil vs. poor quality loamy soil). This design required 96 trials (2x2x2x2x3x2), which with three replications required 288 plots, each 2.5 x 2.5 m (or 240 in the Anjomakely trials, since there were no trials with no fertilization on the poor soil in that split plot design). Because the values for the spacing factor in both sets of trials were both within the SRI range and yielded essentially no difference, 0 t/ha or 0.08 t/ha (N = 288 and N = 240), in our analysis we combined the spacing trials which means there are *six replications*, not just three, for each of the factor combinations reported.

Results have been reported in their theses (Rajaonarison 2001; Andriankaja 2001) and are being reported in more detail elsewhere. The findings are summarized in the following table. The number of plots included for the respective averages is shown in parentheses.

	Morondava (same soil)			Anjomakely (same variety)		
	HYV	Tradl.	Ave.	Clay	Loam	Ave.
Conventional Practices:						
mature seedlings, 3 per hil	2.84	2.11	2.48	3.00	2.04	2.52
saturated soil, NPK fertilizer	(6)	(6)	(12)	(6)	(6)	(12)
Average with 1 SRI practice:	3.39	2.67	3.03	4.25	2.83	3.54
young seedling, or 1 per hill,	+0.55	+0.56	+0.55	+1.25	+0.79	+1.02
or aerated soil, or compost	(24)	(24)	(48)	(24)	(24)	(48)
Average with 2 SRI Practices	4.10	3.27	3.69	6.74	3.57	5.16
	+0.71	+0.60	+0.66	+2.49	+0.74	+1.62
	(36)	(36)	(36)	(36)	(36)	(36)
Average with 3 SRI Practices	4.68	4.28	4.48	8.31	4.59	6.45
	+0.58	+1.01	+0.79	+1.82	+1.02	+1.39
	(24)	(24)	(48)	(24)	(24)	(48)
All SRI practices:	6.83	5.96	6.40	10.35	6.39	8.37
young seedling, 1 per hill	+2.15	+1.68	+1.92	+2.04	+1.80	+1.92
aerated soil, compost	(6)	(6)	(12)	(6)	(6)	(12)

*6. How can such high yields be obtained on such **nutrient-deficient soils**?*
This is a challenging question. We think that the increased tillering and root growth can be explained based on existing knowledge, discussed below. But it is a puzzle as to how such high yields can be obtained on soils that are deficient in all nutrients (and with high levels of Fe and Al -- in many areas around Ranomafana there is serious iron and aluminum toxicity). pH levels range usually between 3.8 and 4.6. In most locations, phosphorus (3.5 ppm) is less than half of what is thought to be the minimum for any respectable crop growth (10 ppm). We have a number of hypotheses that deserve examination. These are based on leads that we have gotten from the literature.

1. **Root development:** The simplest explanation, and surely a crucial part of SRI, is the much greater development of root systems with SRI methods. When rice is grown under flooded conditions, the roots, especially with plants placed in clumps and planted close together, do not develop much depth. Most of the fine roots are in a mat close to the surface, reflecting the root system's demand for oxygen, which it can get at the water-soil interface from oxygen dissolved in irrigation water than more deeply in the soil. In general, under irrigated conditions about 75% of rice roots are concentrated in the upper 6 cm of soil (Kirk and Solivas 1997: 619). This, however, is not necessarily the way that rice roots grow "naturally," i.e., when there is a good supply of oxygen in the soil.

If chemical fertilizer is provided abundantly at the same time as water, the roots can be "lazy," since they do not need to grow in search for water and nutrients.

With SRI practices, the root system is several times larger and considerably deeper, enabling them to access more nutrients even in nutrient-poor soil. A large root system is more likely to capture some of the essential trace minerals like Zn, Mg, B and other elements that are important for plant growth and health. This will give the plant *more balanced nutrition*. Possibly the mechanical hand weeder used with SRI by pruning some of the upper roots encourages deeper root growth, though this is at present conjecture.

This first possible explanation is essentially structural or mechanical. It focuses on plants' *increased access to nutrients* that can result from having a larger root system which itself results from the way that an SRI rice plant is managed. Early transplanting is essential for this effect; it not only preserves plants' greater tillering potential but an accompanying potential for greater root growth.

2. **Biological nitrogen fixation (BNF):** Rice plants producing 8, 10, 15 or even 20 tons per hectare require large amounts of nitrogen, which is quite evidently not present in the soil. The amount of nutrients added through compost cannot explain the observed yields. There is a small body of literature on BNF in rice that is not yet very encouraging. As much as 70 kg/ha of N can be provided by diazotrophic microorganisms in, on and around the roots of rice plants (Ladha et al. 1998: 56). This would, however, not be sufficient for the kinds of yields achieved with best SRI practices.

Most of the BNF research has considered rice grown under flooded, i.e., *anaerobic* soil conditions. The work of Johanna Döbereiner and associates in Brazil has shown that sugar cane, also a gramineaceous species, can get 150-200 kg/ha of N through BNF, which is more in the range that would be required for high rice yields. While most people think that BNF is associated only with leguminous species, practically all gramineae (grass) species can benefit from BNF accomplished by associated microbes in, on and around the plants' roots. The research by Döbereiner, summarized in (1987), found that BNF is not a fixed capacity, but rather more a contingent one. More BNF has been observed in soil that has not had N fertilizer applied, and with cultivars that have not have N fertilizer applications through several generations.[4]

There is a symbiotic relationship seen between plants and the complex associations of microorganisms that live in the rhizosphere and on and in the roots. Microorganisms are able to transfer capabilities *within generations and even among species* through exchange of plasmids that contain genetic material, as shown by the work of Lynn Margulis and others (Margulis and Sagan 1986). Döbereiner (1987) postulates that BNF is a capability that can increase or decrease within *populations* of microorganisms according to plant requirements, not being the result of just a single species. About 80% of the bacteria found in rice roots are N-fixing (Ladha et al. 1998: 57, citing Watanabe et al. 1981).

[4] This could explain, at least in part, why researchers outside Brazil have had difficulty replicating some of Döbereiner's results, if they treat BNF as an inherent quality rather than as one that has responsive or evolutionary qualities.

The only literature we have been able to find assessing differences in BNF between aerobic and anaerobic soil conditions indicates that BNF is greater when aerobic and anaerobic soils were continuously mixed compared to anaerobic or aerobic soils alone (Magdoff and Bouldin 1970). The increased yields observed around Ambatovaky and also on the west coast around Morondava (Bonlieu 1999) were associated with additional weedings with the "rotating hoe" which churns up the soil might be explained, at least in past, by such a dynamic, where layers of more and less aerobic soil are mixed together.

The water management regime with SRI which involves alternatively wetting and drying the fields could also contribute to the BNF dynamic that Magdoff and Bouldin observed. Recent research in the U.K. found that alternatively wetting and drying soils increases greatly, by 185-1900%, the amount of water-soluble P in soil. The researchers suggest that this dynamic could also increase nitrogen mineralization in tropical soils. Under aerobic, unflooded conditions, populations of aerobic microbes can flourish which are then killed by osmotic pressure when the soil is wetted, making their contents available (Haygarth and Turner 2001). Research on such dynamics and effects is overdue. Most soil analyses focus on inorganic rather than organic forms of nutrients. There has been no interest in the effects of alternating aerobic and anaerobic soil conditions because it was presumed that rice should be grown in a continuously flooded, anaerobic environment.

3. **Demand-Constrained N Uptake**: It is widely recognized that rice uptake of N is very "inefficient," with sharply diminishing returns as more N is supplied through fertilizer (Kirk and Bouldin 1991; Ladha et al. 1998). Only 30-40% of the N applied to fields is taken up by rice plants. Kirk and Bouldin (1991: 199) report that the uptake rate of N is "independent of the concentration (of N) at the root surface." Rice plants have very sophisticated (and poorly understood) mechanisms for *down-regulating* uptake when their internal N status is satisfactory. They up-regulate their capacity for uptake when their need is greater.

A model of N acquisition in rice plants that is driven more by demand than by supply would explain the low efficiency of N applications and the observed diminishing returns. Quite possibly we have been overestimating plants' N requirements by focusing so much on supply. We do not know how much N rice plants can get from their rhizosphere when and as they need it. Possibly rice plant growth is not as constrained by N supply as has been thought but rather by the conditions under which rice plants are grown.

With SRI practices, when seedlings are transplanted very early and very carefully -- with no trauma to the root and no malpositioning thereof, and with favorable soil conditions -- the plants can go through a very rapid, *indeed exponential*, growth of tillers and roots, as discussed below. This pattern of growth would create very considerable demand for N, causing the roots to up-regulate their uptake of N to meet plant needs.

One possible reason for the down-regulation of N uptake even when N is abundantly available in the root zone could be that plants need a "balanced diet" of nutrients. With a stunted root system, they do not get the trace elements that are needed to utilize properly the N available for plant

growth. The plant protects itself when it lacks enough of other nutrients for "balanced growth" by shutting out N, or by efflux of ammonia that offsets influx.

Thus, the SRI plant-soil-water-nutrient management practices that result in accelerated tillering and root growth during the vegetative growth phase could be creating the necessary demand to drive N uptake, provided that the plant has sufficient intake of other nutrients needed for healthy growth.

The twist that this model gives is that the plant is seen not as a biological machine, which we can force to grow by putting more inputs into it, but more as a biological organism, which has its own needs and capabilities that we would be well advised to understand and work with, rather than try to warp for our purposes. Possibly there has been a huge waste of expenditure on N fertilizer, with environmental as well as economic costs, which could be averted with a different tack.

4. **Overestimation of Plant Nutrient Requirements:** An even more radical explanation, consistent with the above, derives from the work of Ana Primavesi, a Brazilian agronomist whose work is widely known and respected in Latin America within sustainable agriculture circles. She reported in her 1980 book on ecological management of tropical soils (translated from Portuguese into Spanish in 1984, but never into English) the following results of an experiment with maize grown hydroponically in nutrient solutions of different concentrations.

	Plant (g)	Roots (g)
Normal solution (100% concentration)	0.43	0.07
Concentrated solution (200% concentration)	0.33	0.07
Diluted solution (2% concentration)	0.31	0.23
Diluted solution, Frequently changed (2% concentration)	0.44	0.56

Unfortunately, as far as we know, this experiment has not been followed up with further study, but this is a research result that begs examination. It suggests that plants can have normal growth with **very low concentrations of nutrients** provided that there is **constant supply** to the root system. There will be compensating growth of roots, such as seen with SRI in the very poor soils of Ranomafana and elsewhere in Madagascar, so that small amounts are continuously accessed to support growth of the canopy and further roots. The beneficial effects of using compost would be consistent with this understanding, as it releases its nutrients very slowly even if they are not provided in large amounts.

Primavesi's results are so far outside our present understanding of plant nutrient requirements that they have been ignored. But if they are correct, or even partly correct, the implications for agricultural theory and practice are immense. Scientists who have been fixated on "harvest index" may be appalled by the "waste" implied by massive root growth. But if the nutrients that go into root structures remain in the soil, they are not lost to the biological system.

The yields obtained with SRI are similarly "far outside our present understanding" of plant potentials. So we are forced to consider explanations that depart from the presently accepted ones, though they should be contiguous and continuous with the body of scientific knowledge that has been accumulated thus far.

The four strands possible explanation sketched above are consistent with things known about rice plant physiology, though not necessarily widely known or yet accepted. They could be mutually reinforcing, in that none is sufficient by itself to account for the large increases in rice production with SRI practices, but collectively they could explain how yields can be achieved that are up to 10 times the national average.

Such dynamics could explain why with SRI, the correlation between number of tillers per plant and number of grains per panicle is **positive rather than negative**. That a negative correlation has been observed in the past is probably due to the conditions under which rice has been grown, e.g., saturated soil, rather than to any inherent characteristic of rice. The shallow rooting and root senescence that have been observed with irrigated rice and have been taken as natural characteristics of rice likewise are probably an artifact of plant, soil, water and nutrient management practices.

*7. What explains the **greater tillering** with SRI?*

"Normal" rice plants will have 5-10 tillers, maybe up to 15 or 20 under best conditions. With SRI, the average number of tillers can easily be 30 per plant, often 50 per plant, and with best management even more. Individual plants can have 80 or even 100 tillers, with huge bases, all coming from a single tiny seedling transplanted when less than 2 weeks old. The record number of tillers with is currently 140, but possibly this will be exceeded with further improvements in understanding and practice.

It is known that when plants are more widely spaced, they will produce more tillers. But farmers do not want to maximize tillers per plant; they want the most grains of rice per unit of land (and per hour of labor and per investment of other inputs). So tillering per se is not an advantage. Farmers and scientists have tended to seek an optimum through higher rather than reduced plant density. This, however, according to Fr. de Laulanié's work is a mistaken strategy. Rather, one should seek an optimum within a strategy of wide spacing rather than dense planting.

What Kirk and Bouldin (1991: 199) say that "the mutual regulation of root and shoot activities is poorly understood. One should not talk about either root or tiller growth as independent activities, since both are interdependent, and anything that inhibits either inhibits both. However, I will write here just of tillering, presenting what Fr. de Laulanié discovered empirically in 1983 and could then explain in physiological terms after he became acquainted with the work of the

Japanese researcher, T. Katayama, who discovered the basic patterns of plant growth for rice and other graminaeceous species that can be mapped in terms of *phyllochrons*.

Katayama's work, done mostly in the 1920s and 1930s, was published in Japanese in 1951. Unfortunately, it has never been translated into English, so English-speaking researchers have little knowledge of phyllochrons. These were reported in French in a book on rice by Didier Moreau (1987). This was how Fr. de Laulanié learned about phyllochrons, which helped explain the superb results he had begun obtaining with SRI methods. Even a three-volume encyclopaedia of Japanese scientific knowledge on rice (Matsuo et al. 1997) contains only a few pages on phyllochrons, with no consideration of their possible implications for raising rice production. A recent dictionary of plant science terms and concepts published by Oxford University Press does not even have an entry on 'phyllochron' in its 500 pages (Allaby 1998).

Little attention has been devoted to phyllochrons, at least with regard to rice. However, in 1995 there was a whole issue of *Crop Science* (35:1), the journal of the Crop Science Society of America, devoted to phyllochrons, considering mostly how they can help to explain the growth and performance of wheat. The only article on phyllochrons in rice was contributed by Japanese scientists who were familiar with Katayama's work (Nemoto et al. 1995).

Phyllochrons are recurrent period or interval of plant growth during which the plant, from its meristem, puts out one or more units (called phytomers) of a tiller, a root and a leaf. The length of time for a phyllochron is determined by a complex of factors, noted below, rather than by a fixed period of calendar time. In Madagascar, the length of a phyllochron can be as little as 5 days, though it can be even as few as 4 days at low altitudes where temperatures are high, and as much as 7 or 8 days at high altitudes with cold temperatures.

This statement already does some injustice to the complexity of phyllochrons, because they can become longer as a result of other factors than altitude and temperature, the most obvious and measurable factors. If the soil is too dry, or too wet and lacks oxygen, or is deficient in nutrients, or is too hard and impermeable, the length of these intervals of growth will become longer. If plants are closely spaced, for example, so that their roots have less space for growth and their canopies are too dense for light and air to be abundant, the intervals will also become longer.

For maximum tillering (and root growth), one wants to complete as many phyllochrons as possible during the vegetative growth phase, before the plant begins its reproductive phase with the onset of flowering and panicle initiation. Rice scientists talk about periods of early tillering, active tillering, and active tillering without appreciating the relationship among the tillers that are being produced, instead referring to them in aggregate, quantitative terms, rather than structural or relational terms.

Katayama discovered the qualitative, structural relationships among tillers, most importantly, that -- provided conditions are conducive -- *each tiller (except for the main tiller) produces another tiller two phyllochrons later*. (The main tiller takes three phyllochrons to begin producing tillers from its base.) This dynamic pattern of plant growth leads to *accelerating increases* in the number of tillers (and roots) if the plant can prolong its vegetative growth period, before it starts its reproductive growth.

Toward the end of the potential vegetative growth period, there can be really rapid tiller and root growth before panicle initiation begins, as shown below. Rather than a logistic (S-shaped) curve of tiller growth that is observed with rice grown under the constrained conditions of flooded soils and degenerating roots leading to severe senescence by the time of panicle initiation, the curve can be instead exponential.

The pattern of tiller/root production in a plant having favorable conditions is as follows:

Phyllochron	New Phytomers	Cumulative No. of Phytomers
1st	1	1
2nd	0	0
3rd	0	0
4th	1	2
5th	1	3
6th	2	5
7th	3	8
8th	5	13
9th	8	21
10th	12	33
11th	20	53
12th	31	84

Note that these numbers follow what is known in biology as the Fibonacci series, a pattern of exponential growth often observed with plant or animal life, where each period produces a number of "offspring" equal to the total of the two preceding periods. (Note that after the 9th phyllochron, the numbers produced in each successive period are reduced by 1 or then by 2, etc., because of physical limitations of space at the base of a tiller for adding more tillers in the respective rings. Rice plants do not achieve the full potential of a Fibonacci series.) The exponential pattern is seen by grouping phyllochrons by threes through 12 phyllochrons of growth:

1-3	1	(4^0)
4-6	4	(4^1)
7-9	16	(4^2)
10-12	63	$(4^3 - 1)$

If phyllochrons are grouped into sets of four, we see a truly exponential path of growth:

1-4	2
5-8	11
9-12	71

There can be many reasons why a rice plant might not be able to complete 12 phyllochrons of growth before it switches into its reproductive mode, shutting down vegetative growth and concentrating its growth energies on flowering, grain formation and grain filling.

The first and most critical reason is that rice seedlings transplanted after the third phyllochron experience trauma or shock that slows their growth (lengthens phyllochrons) so that the plant cannot complete as many phyllochrons before switching from vegetative growth to begin reproduction. When seedlings are transplanted in their initial growth stage, before the fourth phyllochron, and if they are transplanted carefully, the trauma and shock can be minimized. The plant proceeds to grow rapidly (with short phyllochrons). When transplanted seedlings are 3 or 4 weeks old, or even older, their biological clock is slowed, and plants complete only 6, 7 or 8 phyllochrons of growth before flowering begins.

Other factors can also slow the biological clock, such as the soil being too dry or too wet or nutrient-deficient. We have seen that plants been transplanted later than the third phyllochron (once they get more than just two tiny initial leaves) lose much of their potential for tillering (and rooting). This is a matter of physiology, following the analysis done by Katayama many decades ago. Unfortunately, the productive implications of his analysis could not be seen until it was linked with different plant-soil-water-nutrient management practices (spacing, water application, etc.) that could bring out the potential for rice plant growth.

Root growth is explained along with greater tillering by the insights one can get from understanding phyllochrons. The master farmer reported above, Ralalason, said that he had one rice plant in 1998-99 with 140 tillers. This means that the plant got into a 14th phyllochron of growth before panicle initiation. Many farmers with SRI have reached 100 tillers, which means that these plants reached into their 13th phyllochron. If a 13th phyllochron of growth can be completed, this will add 50 tillers (134 total), while a 14th phyllochron could add 80 tillers (for a total of 234). This latter number is for now purely hypothetical.

Fr. de Laulanié thought that when sufficient knowledge had been gained about phyllochron dynamics and the conditions under which rice plants could perform maximally, yields as high as 20-30 tons per hectare would be possible with rice. This suggestion will astound rice specialists who have concluded that there is presently a "yield ceiling" for rice between 12 and15 t/ha. Laulanié was persuaded from his decades of work with rice that super-yields could be attained with existing genetic potential, by varying management practices to better accommodate plant requirements.

*8. Do SRI principles apply only for **transplanted lowland rice**?*
No. We have done some experiments adapting SRI concepts to **upland rice**, not involving any transplanting or water management, but using spacing, compost and soil aeration, and have gotten a yield of 4 t/ha. Our purpose was to find some alternative to slash-and-burn cultivation of rice in upland areas. This compared very favorably with traditional upland yields of 0.8-1.5 t/ha and was achieved with compost and a small amount of fertilizer, no burning. It did require, however, more labor input. The main constraint is the labor time required for cutting up (shredding) leguminous shrub branches (tephrosia and/or crotalaria) to produce the mulch needed to suppress weeds, provide nutrients, and retain soil moisture.

We have also tried **direct seeding** while evaluating the effects of varying SRI practices, with good results. Some of the plants had more than 100 tillers, but we could not get any yield data

because locusts devastated this profuse test plot. The principles of SRI should not require transplanting, which is probably more of a detriment than benefit. A Malagasy woman farmer reported to us in January 2000 that she had divided her small farm (just 13 ares) into two parts, half transplanted and half direct-seeded, with no real difference in yield, but some saving in labor time. She was persuaded that direct seeding could be more advantageous than transplanting. This is another area for evaluation.

*9. What are the best **transplanting practices** for SRI?*
We see the transplanting step in rice production as crucial, because so much of the success of SRI depends on vigorous and extensive root growth, to support the increased tillering and then the greater grain production. Much of the loss of potential yield with conventional practices we see as due to inappropriate, even harmful transplanting practices, quite apart from the over-maturity of the seedlings.

With SRI, the young seedlings are removed very carefully from the nursery with a trowel or other implement so that the seed is not separated from the tiny root. (The nursery has been managed like a garden and not flooded, just watered as needed with a watering can.) The seedlings are transported quickly to the field and kept covered and moist, so that the roots do not become desiccated. Because there are so few seedlings required, transport is easy. They should be transplanted with 15-30 minutes.

Most important, the plants are **not plunged down vertically into the soil**, as this is likely to invert their root tips, giving the transplanted seedling a *J shape* with the root tip oriented upwards. When situated in soil this way, the plant requires time and energy to reorient its root tip downward so it can resume growth. SRI plants are laid into the soil with a **sideways motion**, so that the root lies horizontally, and the seedling has more of an *L shape*. Actually, an *I shape* would ideal, but this is very difficult to achieve.

Seedlings that have been taken roughly from the nursery will lose many of their fine roots. To the extent its roots are allowed to dry out, the plant's growth will be set back, and fewer phyllochrons of growth will be achieved. If plunged into standing water, which is a hypoxic environment, the plant will experience even more trauma, especially if its root tips have not been properly oriented for quick resumption of growth.

Transplanting shock can last 1-2 weeks (Kirk and Solivas 1997: 618). This is time taken out of the vegetative growth phase, reducing rapid tiller and root growth at the end of that period. When farmers are planting hundreds of plants per square meter, they cannot give each of them the care that SRI recommends. But when spacing is only 25 by 25 cm (16 plants per m^2), or 50 by 50 cm (4 plants per m^2), farmers can afford to give what we call 'TLC' (tender, loving care) to each seedling. The effort will be repaid if water management and weeding practices support the accelerated growth of the plant.

*10. What about the **sustainability** of this system?*
Can these high yields be maintained on poor soils? In general we find that farmers' yields go up over time rather than decline, reflecting greater confidence and skill in using the methods. Possibly skill factors are masking soil nutrient depletion, but our observation is that the methods

of soil, water, plant and nutrient management enrich the soil, by supporting greater microbial biodiversity, which is makes unavailable nutrients available through such processes as phosphorus solubilization. But answers to this question need to be empirical, and we do not have enough evidence to provide a confident answer. Probably at some point, there will need to be inorganic amendments of nutrients such as P, but our hope is that with higher production and profits, farmers can afford to make such soil amendments.

*11. Can a **labor-intensive strategy** of agricultural production succeed in today's world?*
This is a very important question. Once one has gotten over the problem of incredulity -- how can cutting the seeding rate drastically and having so few plants give double or more the yield? -- and the physical constraint where farmers have field-to-field irrigation and thus little control over their supply, the labor-intensity of SRI is the main barrier to adoption of SRI. We recognize that this is a problem for many farmers, particularly the very poor who have little land and must invest their labor in immediate returns to feed their families on a day-to-day basis. They cannot afford to wait three months for a high return on their labor.

What we do know and can say is that the returns to labor should be at least 50% higher with SRI compared to conventional methods. (This calculation is based on a detailed analysis of the practices and returns for 108 farmers in Madagascar who are practicing both SRI and conventional rice production on their farmers, which controlled for soil quality and for farmer skill differences.) Since the returns to land and water as well as labor are higher with SRI, it is advantageous -- if labor supply is a constraint -- to practice SRI on just a part of the household's rice land, and to use the rest of the land for some other productive purpose at a time and in a way that does not compete with the rice management cycle. If a household does not have enough labor to use SRI for its entire rice land, it will be better off using the methods on part of its holdings. This seems counterintuitive, but so is much about SRI.

In fact, there may be reason to question whether SRI is or needs to be labor-intensive. During a recent visit to Sri Lanka when some farmers using SRI practices were asked how additional labor was required per hectare to use these methods, several farmers who have been using them for several years now and have gained skill and confidence replied that they are finding that SRI requires ***less labor per hectare*** than the conventional modern methods they had been using, e.g., applying four sprayings of pesticides per crop -- if this labor is saved, this can be better used in the weeding operations, and they now find that they require less labor for transplanting with SRI. So possibly we may find that SRI is not even more labor-intensive on average, though when the methods are first used, they definitely will require more time to be invested in acquiring skills to manage rice more carefully and effectively.

Further Issues
These are not the only questions that could be asked, but the answers give a good understanding of this methodology for raising rice yields. Association Tefy Saina and CIIFAD to not refer to it as a 'technology' because it is not a set of practices to be adopted as a package. There are some core principles, with which certain practices like use of young seedlings or early and frequent weeding (soil aeration) are associated. But farmers are encouraged to approach SRI experimentally, at least varying the spacing and water management to learn what will give the best results under their particular soil and other conditions.

Association Tefy Saina, CIIFAD and our colleagues in FoFiFa and the University of Antananarivo have been trying to construct plausible explanations for the remarkable increases in production that we have seen SRI make possible. These are still hypotheses that need to be examined and confirmed, or disproved, by plant and soil scientists who have the appropriate training, methodologies and means.

To test these hypotheses thoroughly and fairly, it will be important for scientists to understand the principles behind SRI and to consider it in a holistic manner, within which particular mechanisms or relationships are measured and tested -- rather than approach SRI piecemeal, examining it in *ceteris paribus* terms, component by component.

We do not ask anyone to accept SRI or to "believe" in it without empirical validation, but rather to approach it with a willingness to explore the possibilities and potentials of synergy. We should at least entertain the possibility that from this examination of SRI, we will emerge with a somewhat different paradigm for understanding rice plants' growth and performance. Possibly this understanding can extend to other crops as we come to appreciate more fully the contributions that soil microbiology can make to more productive and more sustainable agriculture, tapping genetic potentials that already exist.

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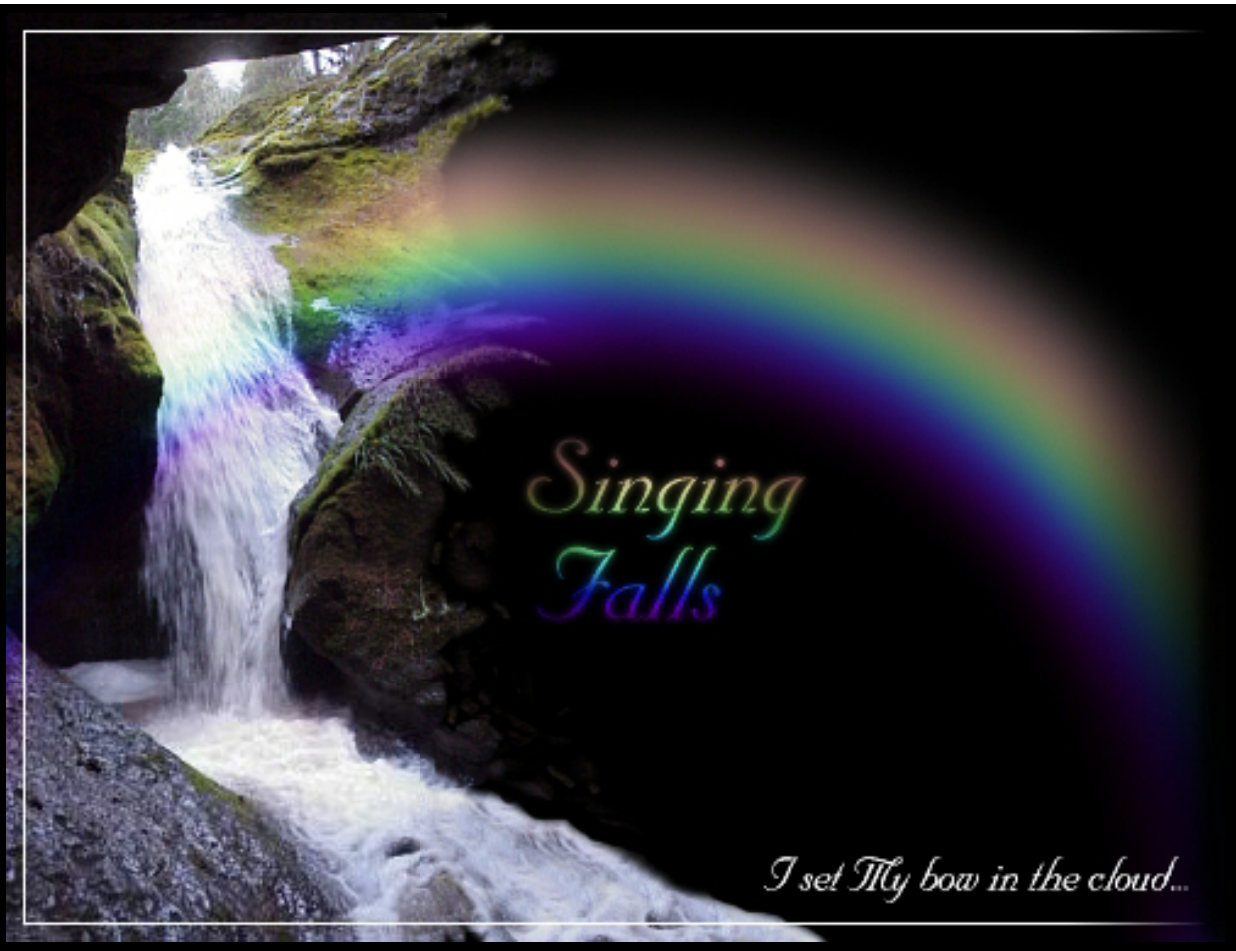

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We realize that one picture is worth a thousand words so images on this site have been compressed for easy processing by your browser. Please take the time to let them download and come back often. I have found that if you view this site in the "full screen 600X800" mode it is much more pleasant to see. We plan on keeping new information posted all the time. If there's something you see or that we say that strikes your fancy, e-mail us and we'll try to keep in touch.

Aside from the mohair fiber industry, we garden with raised beds and tend a small fruit orchard and vineyard. Gradually we are adding low impact techniques of farming and animal husbandry that will make this land productive and self-sustaining.

Some who have followed our homesteading sojourn on the net know that a pair of Holsteins named Bright and Tears, helped us build this place. Those oxen pulled some mighty heavy loads. This last September our nigh ox, Tears, died an untimely death, which dealt the homestead a severe blow, not to mention his master, Stan, who had a rough go of it emotionally after Tears' demise. There are not a lot of ox drovers in our great nation anymore, but it is interesting that of those who are drovers, there is a great bond. Any drover who found out about Tears' passing immediately sent his condolences. One said, "it's like losing family." Indeed it was.

Now there's Bright alone on this homestead. He's learning slowly to live without his brother and at first we wondered if he would make it for the grief. He lost a lot of weight in spite of a hearty appetite. Now, a few months later - he's finally starting to gain weight again. We watch him carefully and silently hope he'll be able to pull the load alone. Right now Stan is ready to make a single yoke for him, hoping to be able to use Bright's muscle solely in future homestead undertakings.

The angora goats, both white and colored, are our mainstay. They provide us with the exotic natural fiber, mohair. The tendrils are hand crafted into high quality heirloom throws, scarves, and yarns. We also sell whole mohair fleeces to other hand spinners and long length mohair ringlets for doll crafters. The colored angora goats are our particular focus, and we sell high quality breeding stock when it is available. Be sure to see the pictures of the angora goat herd, the craft, and mohair fiber pages. The gallery contains many of our fiber arts products.

We hope to make this web site an exciting place to visit for those who love the homesteading lifestyle, whether still stationed in the city or already pursuing their own country dream. We present our mohair products as a meaningful part of our

lives, an extension of our entire lifestyle. We believe in what we are doing and hope to establish communication with like minded folks everywhere. The webring navigator bars below will lead you to other folks with similar interests. If you have questions or comments feel free to contact us. We'll do our best to catch up to you. We also design web sites. If you like this format, let us know if we can design your presence on the www.

Sincerely,

Stanley and Alexandra Petrowski

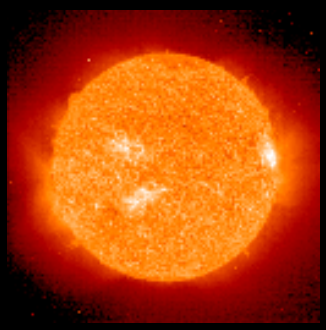
Singing Falls Ranch

34620 Tiller Trail Hwy.

Tiller, Oregon 97484

email us at mohair@singingfalls.com

This is the Mount Sexton Weather Underground report. Usually we are about 10-15 degrees warmer at Tiller. Click for the forecast.



This small solar image is the latest SOHO EIT image.It is updated daily. The NASA sun information page can be found by clicking the picture.

The moon phase provided courtesy of the US NAVY. It is updated every four hours. Also go here to see an in depth tool chest of time from the USNO

Below are some of our favorite links.

Homesteaders Web Ring

This Homesteaders Web Ring site owned by

Singing Falls

[Previous |Next |Next 5 |Random |List Sites]

This Mohair & Angora Goat Webring site by

Singing Falls

[Previous |Next |Next 5 |Random |List Sites]

Thisfiberart ring site is owned by
Singing Falls.
[Previous | Next | Random Site | List Sites]

Goat Community Web Ring

Singing Falls

[Previous |Next |Random |List Sites]

02/08/04 was the last update.

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homesteaders

Join This Ring

RingMaster: mohair RingMaster's site

Home > **Family & Home** > **Home and Garden**

About this Ring

Homesteaders web ring is a gathering point for homesteaders and those who wish to embark on small scale farming.It includes sites that focus on rural skills and a self-sufficient lifestyle. Sites centered on animal husbandry, alternative energy, gardening and agriculture, are welcome. We hope to be a repository of self help skills ranging from log home and timberframe construction to working with forges and draft animals, spinning and weaving to sustainable farming methods.

Ring Stats

- Created 09/14/1998
- 88 active site(s)
- 52 page views today
- 66712 total page views
- details

Sites in Ring - Navigation Rating: 95 what's this?

Sites 1 - 20 of 88

Next 20 >

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Garden Home

My small cottage and the garden and treasures I create.

The Ozark Seed Exchange

A free, open-membership Seed Exchange for the preservation and distribution of heirloom, non-hybrid, non-genetically modified seeds.

Sunstar Herbs

We are a family based sustainable agriculture venture south of Santa Fe, New Mexico just outside Madrid. We grow native and naturalized medicinal herbs, raise goats and birds for food and sell the surplus. We collect and wrap smudge sticks from sage wild crafted in Taos, New Mexico, and make catnip kitty toys from our own high altitude catnip.

Cummins Nursery 2004

Cummins Nursery providing fruit trees and small fruits for your homesteader orchards and gardens.

Feline Gardens - A Walk in the Garden

A stroll through the garden reveals beauty and insight to life itself. On this page you'll find photos & information about the plants growing in the garden as well as helpful links and articles from other sources.

Sierra Cottage Art

Life and Art in a Sierras

Windhaven - New Mexico

Windhaven is a forming community just east of Belen, NM (about 30 miles south of Alburquerque). This list and the coming website will be the virtual beginnings. Paganism,Permaculture,Wholistic Health and Well-Being,T'ai-Chi(and Internal Martial Art/Yogic systems),Tantra/Sacred

Sexuality/Erotic Spirituality, along with associated practices.

JIM'S WORKSHOP

Homesteading,survival,make it yourself,Alt.Energy

Mini Farm Homestead

All the resources a modern homesteader needs. Books,magazines,tools, seeds,hunting & fishing equipment,and more. Read our articles for help on companion planting, taming good and bad critters or raising livestock. The one-stop-site for homesteaders.

CABIN FEVER

A journal of two people's upcoming escape from urban jungle to rural wilderness. We intend to document every step of the way - finding and purchasing a rural plot of land, acquiring building materials, and building a small cabin from foundation to finishing. Resources for homesteaders and off-the-grid living.

Cherries Country Market

Supplier of Organic and Natural Health Products for You and Your Home

Thomas Keating's Survival Website

independent living,self sufficiency, homesteading,natural living,preparedness,survivalism,alternative energy, alternative living,survival skills, home survival,surviving terrorist attacks,disaster preparedness,building,tools,backwoods home,farming,gardening, guns,weapons,hunting,fishing,backwoods home,animals,livestock,food, disaster planning

Tabletop Homestead

Modern homesteading in southern Oklahoma

The Knapp's Earthship Adventure!

Join us as we explore natural building and renewables to create a positive living experience and to set an example for all to follow.

Free-Range Egg and Pastured Poultry Information

All sorts of information on brooding chicks, producing free-range eggs, and raising pastured broilers.

Anala Goat Company

We have a small goat dairy southwest of Houston, Texas. We milk Saanen and Alpine goats. We also raise colored Boer Goats. We are concentrating on creating a sustainable farm.

Anioleka Seeds

Specialists in rare heirloom vegetables; especially Tomatoes, Cucumbers, Eggplant, Squash, Melons and much more. We import rare traditional heirloom seed varieties from around the world. WE SHIP WORLDWIDE!!! Site features

an extensive, detailed seed catalogue with a secure order system as well as gardening tips and hard to find information!

Survival Bill's Outdoor Retreat

an outdoor retreat were we test out frugal living items to make life easyer on the homestead.

Joyfire Hollow

This is a MSN Group for alternative living, parenting spirituality and simple living homesteading, natural healing ect.

Country Vista Alpacas

Harvesting luxurious alpaca fibre for all spinning, knitting and fibre arts projects. All fibre is sorted in standard grades improving the quality of the end product. Breeding pedigree alpacas for diversity and distinction.

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The Agriculture Web Ring

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RingMaster: sunfunsandwine

Home > **Business & Finance** > **Companies** > **Agriculture**

About this Ring

All agricultural sites are welcome to join, commerical, non-commercial, foreign, etc. Unlimited banner advertisements for members! The Agriculture Web Ring!

Ring Stats

- Created 12/31/1996
- 123 active site(s)
- 46 page views today
- 50874 total page views
- details

Featured Site(s)

The Ultimate Citrus Page

The Ultimate Citrus Page is the most complete listing of links to web sites related to the Florida citrus industry. Come visit and learn more about citrus, oranges, grapefruit, and orange juice.

Sites in Ring - Navigation Rating: 99 what's this?

Sites 1 - 19 of 123

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Agriculture Glossary

Agriculture - a collection of several hundred terms related to agriculture.

The Coop

The Coop - Your Key To The On-line Poultry Community. The Coop provides extensive access to poultry oriented resources, free classifieds, show info, an e-mail directory of poultry people, photo essays, articles and reference materials plus an extensive links list and much much more!

Welcome To Smokey Valley Farm

Six Breeds of Rare, Miniature and Toy Sheep. Also the Founders of the Miniature and Novelty Sheep Breeders Association and Registry (M.N.S.B.A.R.). Breeders of French Bulldogs, English Toy Spaniels, Miniature and Toy Australian Shepherds.

noflats.com

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The Ultimate Citrus Page

The Ultimate Citrus Page is the most complete listing of links to web sites related to the Florida citrus industry. Come visit and learn more about citrus, oranges, grapefruit, and orange juice.

Aftermarket Ag Parts

We sell new and rebuilt parts for agricultural tractors. Because we have low overhead, we can keep prices low.

Deger Tractor Seats

Manufacturer. Products are Tractor Seats, PTO Powered Air Compressor and Bird Scarer Device.

Berry Farm Inc. Web Site

Berry Farm Inc. Web Site. We have one of the finest genetic program in the State of Michigan. Our breeding program is focused to produce functional cattle for performance, structural correctness, muscle and fleshing ability.

Direito Agrario

Agricultural Law Directory of ESTIG/Beja Polytechnic, Portugal

The Vendeen Sheep Society Ltd

Site of the British Vendeen Sheep Society

Maine Tractor Crossing

selling/buying tractor parts and tractors

Agriquip, Inc.

Importer of small tractor hay tools since 1991, offering Marangon Disc Mowers and Star Mini Hay Tools (13-30Hp) Pine Straw Balers

HorseSticker.com

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Fitzpatrick Cattle Company

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Longlane, LLC Restoration

Longlane, LLC seeks to promote Antique Tractor preservation by offering premium restored tractors and restoration services to individuals interested in antique farm equipment, vintage automobiles and motorcycles.

The Power Connection

Emergency power Generators for the farm. PTO, Gas, propane, deisel. Best prices in the country

Billy Joe Jim Bob's Home on the Internet Range

Over 1800 links to all kinds of Ag-related & Country sites

Dunton Family Farms

Our farm is located in the beautiful Willamette Valley of Western Oregon. Our ancestors moved here in the late 1800s. Great-grandfather, Victor Hugo Dunton, built the house and farm at which we live. Our children are the 5th generation to be raised on this land and 6th in our community. Along with nuts, eggs, seasonal produce, and plant starts, we raise and market heirloom from our Web site.

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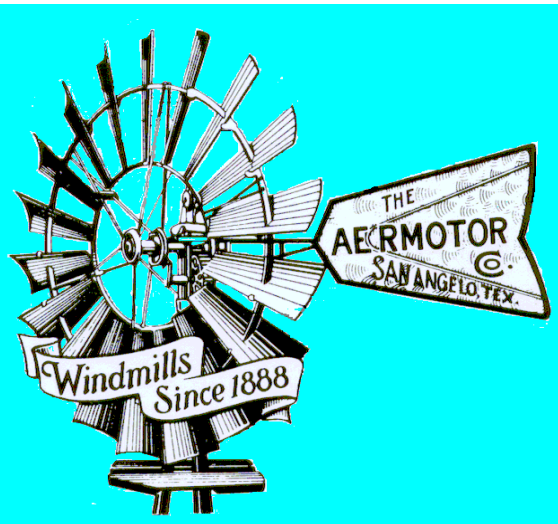
for WATER WELLS



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Lincoln, Arkansas

479-824-5494

Visitors:

"For I know the plans that I have for you," declares the Lord. "Plans for welfare and not for calamity; to give you hope and a future."
Jeremiah 29:11

There is a wonderful site, shared with me by my dearest friend, Karen of Whippoorwill Farm, that speaks to those of us who "shepherd a flock." It is called The Good Shepherd. I hope you will be as blessed by it as I was.

Connie

This site is a member of WebRing. To browse visit
http://ss.webring.com/navbar?f=l&y=appagal&u=99508373110049504

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Perhaps the best thing to hit the livestock community!

Welcome to the LiveStock Sales Network. We hope you enjoy your visit and find this site valuable.

Inside, you'll find a comprehensive livestock auction market directory, links to various livestock market reports by the USDA and other sources, and more.

(To View, Download Java Software)

We've designed the site to better promote the livestock industry of the United States and we hope you agree.

If you're the owner of a livestock, or agriculture-related business, we invite you to let us positively represent you through one of our many advertising services. You'll find our services hard to beat and of the highest quality. Feel free to drop us a line if you have any questions!

Now, kick off your boots, hang up your hat, grab that cup of coffee that's just finished brewing and come on inside for information regarding livestock sales in an area near you.

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The Agriculture Web Ring

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About this Ring

All agricultural sites are welcome to join, commerical, non-commercial, foreign, etc. Unlimited banner advertisements for members! The Agriculture Web Ring!

Ring Stats

- Created 12/31/1996
- 123 active site(s)
- 47 page views today
- 50875 total page views
- details

Featured Site(s)

The Ultimate Citrus Page

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Ace Millwright Inc.

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Hardtime Helicopters - A Safetynet Associate

Hardtime Helicopters offers a wide range of helicopter related services, from surveillance and ranch security to crop dusting.

Pepperclicks THE Pepper Directory

Pepperclicks is THE vendor-neutral Pepper Directory for everything from Seeds

to Fresh Peppers to Hot Sauces. Growing tips and recipes, too. Much more than just hot !

Todd's Tractor Pages

Personal tractor history, plenty of detail pictures of my John Deere 1949 A and John Deere 1955 40 Utility, 40U restoration in progress. Other John Deere 40 information. How to obtain John Deere Service Publications, with samples.

Stone Crest Stock Farm

A cattle and Horse farm in Hagersville, Ontario

South Caldwell FFA

South Caldwell FFA's First Stie

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PAGINA PRINCIPAL - LA MISION	IMAGENES SATELITALES	INDICE DE VEGETACION
¿QUE ES LA PERCEPCION REMOTA?	AGRICULTURA Y FORESTACION	NUESTRA ESTACION RASTREADORA
PLATAFORMAS DE OBSERVACION	MEDIO AMBIENTE	DESARROLLO URBANO
NUESTROS SERVICIOS	RECURSOS NATURALES	ENLACES A SITIOS DE INTERES
FOTOGRAFIA AEREA MULTIESPECTRAL	ANIMACIONES: ACTUALIZACION DIARIA	PROYECTO SEAWIFS: SATELITE SEASTAR

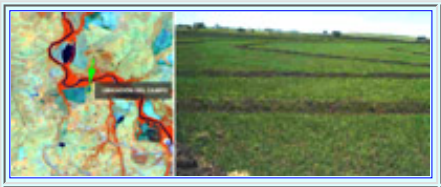
AGRICULTURA:

Aplicaciones agrícolas y forestales de la teledetección satelital en Uruguay

Cultivo de Arroz

Monitoreo multitemporal de la evolución de un cultivo de arroz mediante el uso de imágenes satelitales de alta resolución.
La arrocera monitoreada corresponde a una parcela experimental de la Escuela Agraria de Artigas (Zafra 98/99).

1. Comparación: composiciones falso infrarrojo del satélite Landsat-5 vs. Fotos de verdad de Campo

		
Ampliar imagen: 30/11/1998	Ampliar imagen: 01/01/1999	Ampliar imagen: 17/01/1999

2. Comparación: Indice Normalizado de Vegetación (NDVI) vs. Fotos de Verdad de Campo

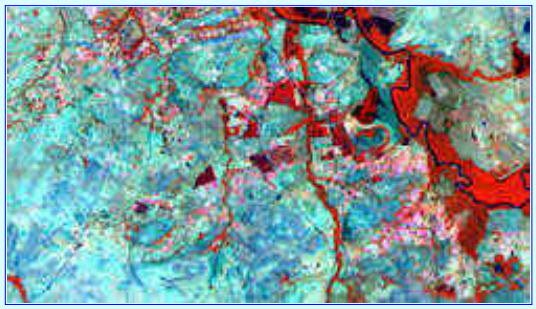
Ampliar imagen: 30/11/1998	Ampliar imagen: 01/01/1999	Ampliar imagen: 17/01/1999

La que aquí vemos, es una subescena de una imágen Landsat que abarca un área de algunos pocos kilómetros cuadrados. Un cuadrante Landsat "full scene" abarca un área de 185x185 kmts mientras que un subcuadrante de la misma cubre aproximadamente 90x90 kmts. Esto quiere decir, que un tipo de análisis como el visto en el ejemplo (que se ha realizado sobre una sola arrocera) puede hacerce extensivo a todo un área de influencia, y es más: puede hacerse extensivo hacia otras zonas de interés arrocero económicamente competitivas (incluso fuera de fronteras). Si bien el cultivo de arroz no es un área temática que hayamos abordado aún con la suficiente profundiad, la experiencia obtenida en la aplicación de la teledetección en otros sectores agrícolas, nos hace suponer que el diseño de modelos que puedan ser sistemáticamente aplicados en este rubro es perfectamente viable, ya que tanto el arroz, al igual que otros cultivos de carácter extensivo, presentan grandes ventajas en lo que a teledetección se refiere: aquellos cultivos cuyas superficies promedio no abarcan más de 3 hectáreas suelen requerir análisis muchos más complejos que los de gran superficie. No obstante ello, hemos obtenido muy buenos resultados en los estudios realizados en tabaco, cuya superficie promedio

plantada por parcela es de aproximadamente de 2,5 hectáreas (esto puede variar de acuerdo a los diferentes países).

Hasta el día de hoy, no hemos tenido noticias de que alguna vez se hayan aplicado técnicas satelitales de Percepción Remota al análisis del cultivo del arroz en el Uruguay, pero como puede verse, su potencialidad es enorme.

Cultivo de Tabaco



Ampliar imagen

17 de Enero de 1999 - Imagen Landsat-5, Composición Falso Infrarrojo RGB 4,5,3 30mts de resolución por pixel.
Zona al Sur de la ciudad de Artigas.

Las zonas cuyo rango cromático va del rosa pálido al rosado intenso son parcelas de tabaco virginia. Una vez más, la utilización de bandas infrarrojas nos permite diferenciar nuestro objeto de estudio, de otras especies vegetales presentes en el área, tales como arroz, forestación exótica y monte nativo (las mas notorias).

Forestación

1 de Febrero de 1997 - Imagen Landsat-5 (30mts de resolución por pixel)
Zona Limítrofe entre los Departametos de Paysandú y Rio Negro, entre las localidades de Piedras Coloradas y Algorta.

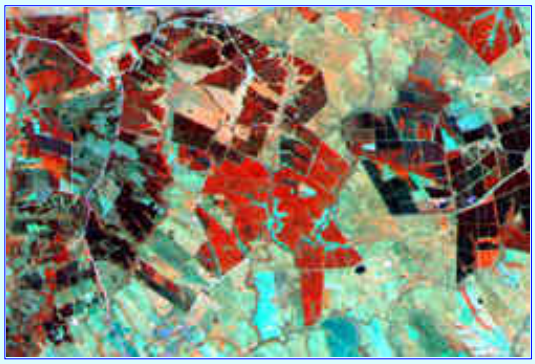
Ampliar imagen #1

Imagen #1: Simulación Pancromática generada a partir de las Bandas Espectrales 3-2-1, correspondientes al rango visible del espectro electromagnético ("lo que nuestros ojos pueden ver").

El producto obtenido es comparable al de una fotografía aérea clásica (blanco y negro) pero de menor resolución (30mts por pixel). Sabiendo de antemano que este es un área densamente forestada, solo podemos concluir en que las zonas oscuras corresponden a montes: no nos es posible discernir entre diferentes especies de árboles (eucaliptus y pinos, en este caso).

Ampliar imagen #2

Imagen #2. Utilizando las mismas bandas espectrales, generamos una composición coloreada de la misma zona.
En este caso, el resultado se correspondería aproximadamente con una foto obtenida con película color: no obstante agregado el elemento color, persiste la dificultad de discriminación de especies.



Ampliar imagen #3

Imagen #3. La misma escena pero en una composición RGB de las bandas 4 (infrarrojo cercano), 5 (infrarrojo medio) y 3 (rojo del espectro visible).
Sensores satelitales como los de Landsat no sólo son capaces de captar y enviar información dentro del rango visible del espectro electromagnético (ejemplos 1 y 2). También son sensibles a otras longitudes de onda tales como los infrarrojos cercano y medio. La radiación reflejada en estas regiones del espectro (que está fuera del alcance de nuestro sistema visual), contiene información de suma trascendencia, muy especialmente en lo que material vegetal se refiere. Es por eso, que aquello que no podíamos ver utilizando métodos clásicos o convencionales, se manifiesta en forma notable al introducir en una combinación de colores, información proveniente de la región infrarroja del espectro. En este caso no sólo diferenciamos claramente eucaliptus de pinos, sino que también podemos, contando con algunos datos de referecia de campo, sacar conclusiones acerca de la edad y variabilidad de manejo inherentes a cada especie arbórea en particular.

Volviendo a la imagen en cuestión, identificamos a los eucaliptus en aquellas zonas que varían desde un anaranjado intenso a un rojo casi purpura; la población de pinos se identifica en un rango que va casi desde el negro, pasando por el marrón hasta llegar a un verde oscuro (ésto en un primer vistazo). Esta variabilidad cromática está directamete asociada no sólo con la naturaleza de cada especie en particular, sino con su edad y tipo de manejo. En un análisis más profundo es posible clasificar y desglosar las diferentes situaciones que puede presentar una determinada población forestal.
Los objetos terrestres, iluminados por la radiación solar, reflejan ésta luego de introducir en ella modificaciones inducidas por la misma estructura y composición de dichos objetos ***(reflectancia)***. Estas modificaciones en la radiación de la fuente emisora (en este caso el sol) generan lo que llamamos ***patrón de respuesta espectral***. Este patrón o ***firma espectra***l nos permite interpretar los diferentes estados de un objeto, en este caso, montes. Los árboles pueden tener distintas edades, ser de distinta especie y/o variedad, y estar sometidos o no al manejo por el hombre. Por lo tanto, si combinamos todas estas variables, nos encontramos con una amplia gama de posibles firmas espectrales en lo que a objetos forestales se refiere. Conociendo con certeza la ubicación y las características de montes testigo previamente seleccionados ,***(verdad terrestre)*** podemos, mediante la utilización de imágenes satelitales, conocer cual es la firma espectral de dichos montes ***(verdad satelital)*** e inferir de que todas aquellas zonas que respondan al mismo patrón espectral, poseen características similares. De esta manera es posible generalizar, utilizando criterios de muestreo adecuados, las características de nuestros montes testigo en áreas forestadas extensas. Además, es posible realizar una estimación de superficie plantada para cada objeto en particular. Si bien este tipo de interpretación y análisis es bastante más complejo y va más allá del objetivo de esta página, propondremos algunos ejemplos de como pueden comportarse desde el punto de vista espectral, diferentes estratos dentro de un área forestada.

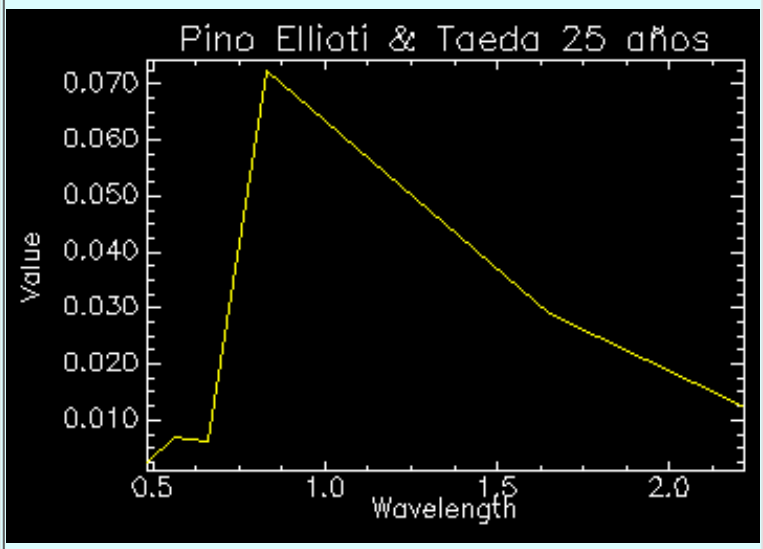
Seleccionemos de la imagen #3, cuatro montes cuya verdad terrestre conocemos (imagen #3a)

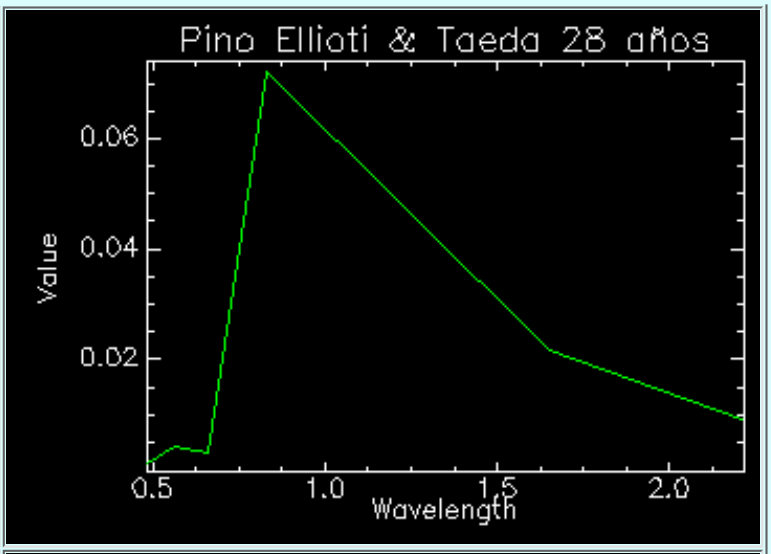
imagen #3a

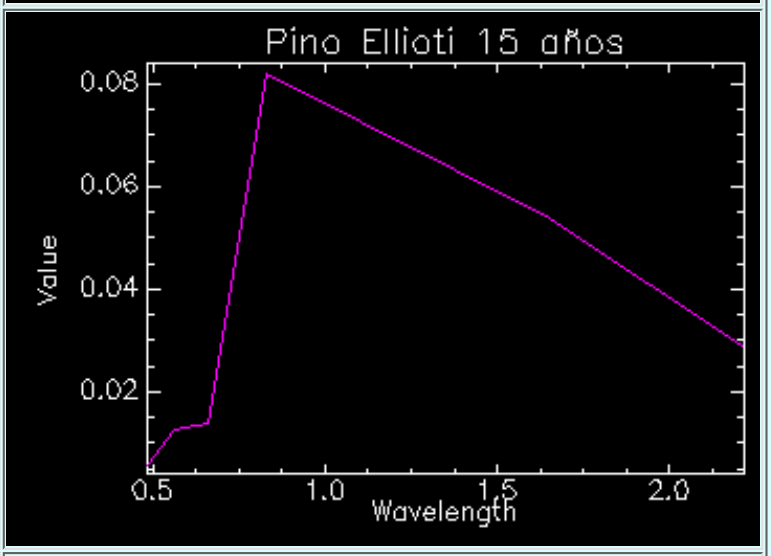
Comparemos ahora fotos testigo de esos montes con sus correspondientes patrones espectrales (los colores de cada gráfico se corresponden con los de las regiones seleccionadas en la imagen #3a):

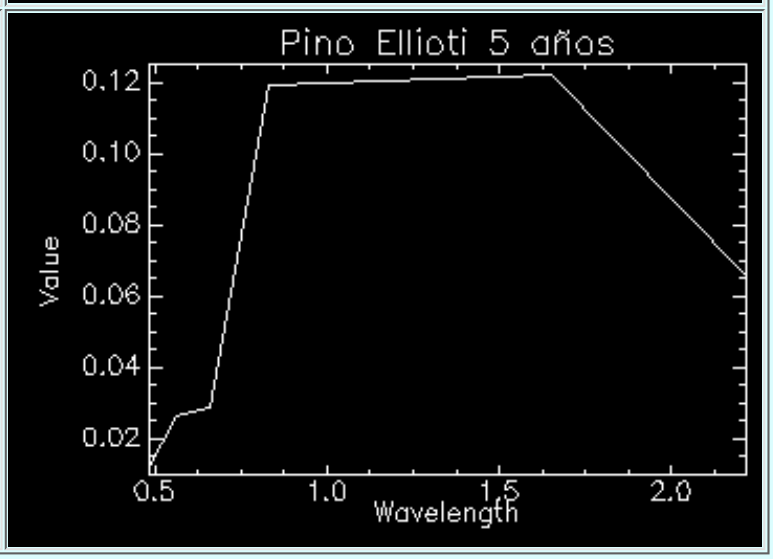
wavelenght = longitud de onda en µm

value = reflectancia

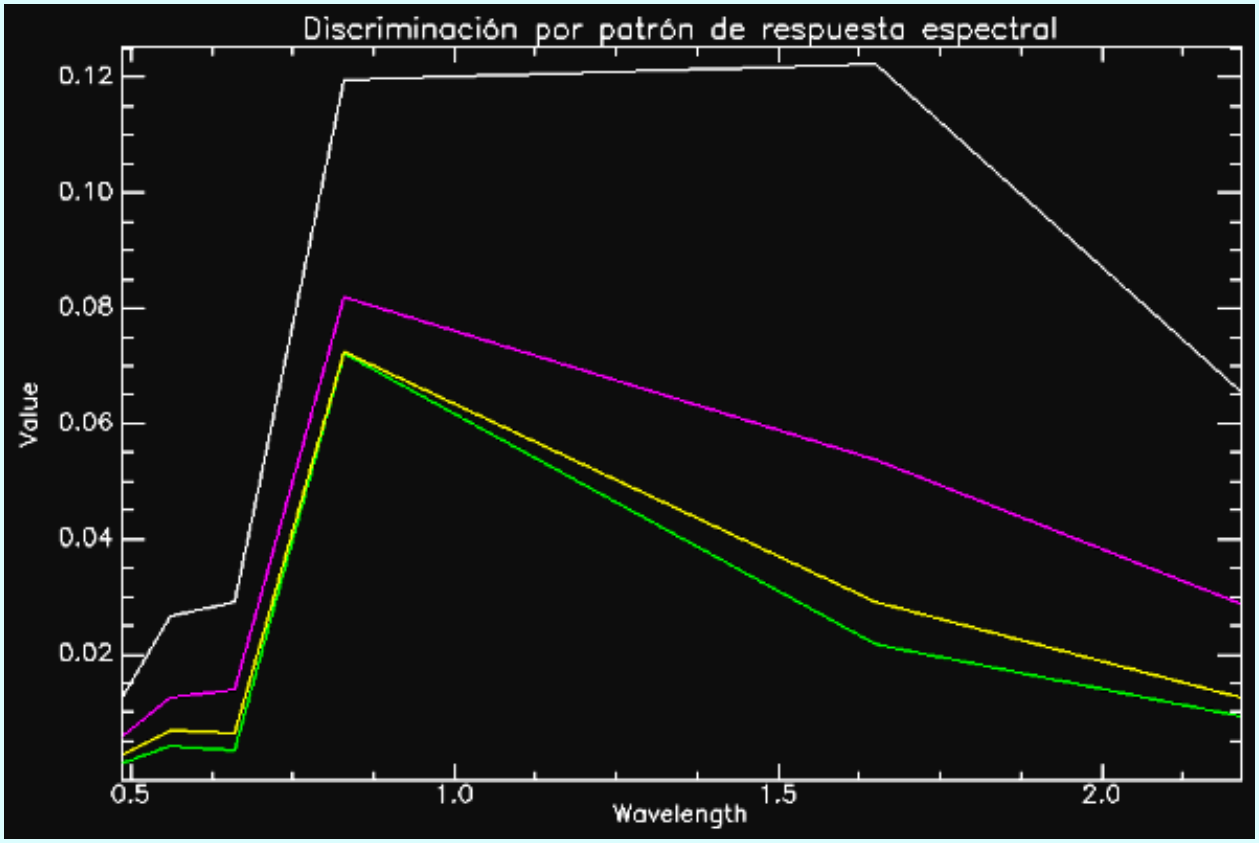








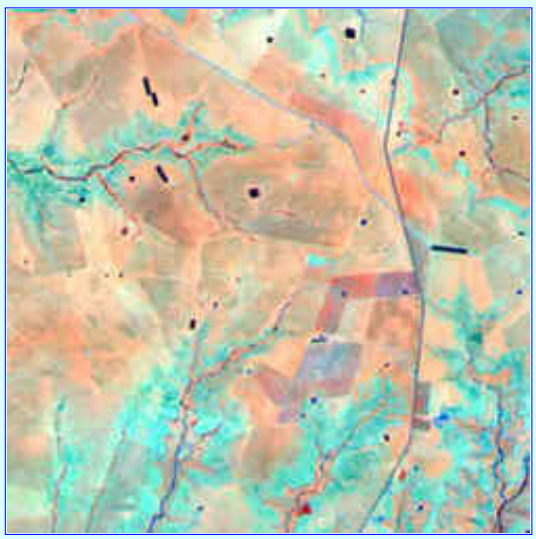
Finalmente, comparemos los diferentes patrones de respuesta espectral entre sí:



Como puede verse en esta secuencia, el sensor del satélite Landsat fue capaz de detectar las diferentes características de estos montes. Inclusive, nótese que aquellos que más se aproximan de acuerdo a sus carecterísticas (Pinos de 28 y 25 años) presentan patrones de respuesta espectral mucho más afines entre sí, con respecto a los estratos de pinos más jóvenes.

Vale la pena insistir entonces, en las ventajas que la Percepción Remota de tecnología satelital ofrece. Como dijimos (y vimos) anteriormente, la región infrarroja del espectro nos "dice" mucho acerca de la naturaleza y estado de las distintas especies vegetales. Y esto no es unicamente válido para el caso de la forestación: siempre que se trate de material vegetal como objeto de estudio, la información proveniente de la región infrarroja del espectro habrá de adquirir carácter vital.

Pasturas



Ampliar imagen

1 de Enero de 1999 - Imagen Landsat-5, Composición Falso Infrarrojo RGB 4,5,3
30mts de resolución por pixel.
Zona al Sur de la ciudad de Artigas.

Obsérvese como se insinúan claramente una serie de polígonos en tonos que van del anaranjado pálido al verde opaco. En algunos casos, estos polígonos se ven demarcados por líneas que evidentemente son caminos, pero en otros casos no. La resolución de Landsat (30mts), impide detectar objetos tales como sendas demasiado estrechas y obviamente, es imposible detectar alambradas. No obstante, la notable diferencia que puede verse entre polígonos adyacentes sin aparente demarcación, evidencia un diferente manejo y/o uso de la tierra. La sugestiva presencia de montes de abrigo (pequeños rectángulos oscuros), aguadas (pequeñas áreas en azul oscuro) y cañadas, nos permite inferir a "grosso modo", que este es un área destinado preferentemente al pastoreo.
Hasta el día de hoy, no tenemos conocimiento de que alguna vez se hayan aplicado técnicas satelitales de Percepción Remota al análisis de pasturas en nuestro país, pero como puede verse en esta imagen y al igual que en el caso del arroz, consideramos que su potencialidad no es nada desdeñable.

(ver SERVICIOS)

PAGINA PRINCIPAL - LA MISION	IMAGENES SATELITALES	INDICE DE VEGETACION
¿QUE ES LA PERCEPCION REMOTA?	AGRICULTURA Y FORESTACION	NUESTRA ESTACION RASTREADORA
PLATAFORMAS DE OBSERVACION	MEDIO AMBIENTE	DESARROLLO URBANO
NUESTROS SERVICIOS	RECURSOS NATURALES	ENLACES A SITIOS DE INTERES
FOTOGRAFIA AEREA MULTIESPECTRAL	ANIMACIONES: ACTUALIZACION DIARIA	PROYECTO SEAWIFS: SATELITE SEASTAR

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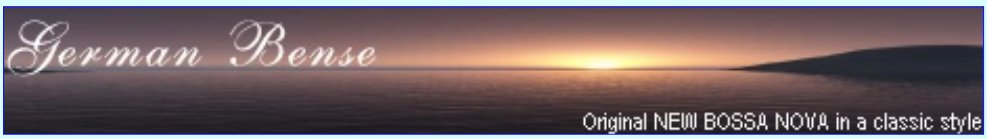

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3 BIOMASS

3.1 INTRODUCTION

Biomass as the solar energy stored in chemical form in plant and animal materials is among the most precious and versatile resources on earth. It provides not only food but also energy, building materials, paper, fabrics, medicines and chemicals. Biomass has been used for energy purposes ever since man discovered fire. Today, biomass fuels can be utilised for tasks ranging from heating the house to fuelling a car and running a computer.

THE CHEMICAL COMPOSITION OF BIOMASS

The chemical composition of biomass varies among species, but plants consists of about 25% lignin and 75% carbohydrates or sugars. The carbohydrate fraction consists of many sugar molecules linked together in long chains or polymers. Two larger carbohydrate categories that have significant value are cellulose and hemi-cellulose. The lignin fraction consists of non-sugar type molecules. Nature uses the long cellulose polymers to build the fibers that give a plant its strength. The lignin fraction acts like a “glue” that holds the cellulose fibers together.

WHERE DOES BIOMASS COME FROM?

Carbon dioxide from the atmosphere and water from the earth are combined in the photosynthetic process to produce carbohydrates (sugars) that form the building blocks of biomass. The solar energy that drives photosynthesis is stored in the chemical bonds of the structural components of biomass. If we burn biomass efficiently (extract the energy stored in the chemical bonds) oxygen from the atmosphere combines with the carbon in plants to produce carbon dioxide and water. The process is cyclic because the carbon dioxide is then available to produce new biomass.

In addition to the aesthetic value of the planet’s flora, biomass represents a useful and valuable resource to man. For millennia humans have exploited the solar energy stored in the chemical bonds by burning biomass as fuel and eating plants for the nutritional energy of their sugar and starch content. More recently, in the last few hundred years, humans have exploited fossilized biomass in the form of coal. This fossil fuel is the result of very slow chemical transformations that convert the sugar polymer fraction into a chemical composition that resembles the lignin fraction. Thus, the additional chemical bonds in coal represent a more concentrated source of energy as fuel. All of the fossil fuels we consume - coal, oil and natural gas - are simply ancient biomass. Over millions of years, the earth has buried ages-old plant material and converted it into these valuable fuels. But while fossil fuels contain the same constituents - hydrogen and carbon - as those found in fresh biomass, they are not considered renewable because they take such a long time to create.

Environmental impacts pose another significant distinction between biomass and fossil fuels. When a plant decays, it releases most of its chemical matter back into the atmosphere. In contrast, fossil fuels are locked away deep in the ground and do not affect the earth’s atmosphere unless they are burned.

Wood may be the best-known example of biomass. When burned, the wood releases the energy the

tree captured from the sun's rays. But wood is just one example of biomass. Various biomass resources such as agricultural residues (e.g. bagasse from sugarcane, corn fiber, rice straw and hulls, and nutshells), wood waste (e.g. sawdust, timber slash, and mill scrap), the paper trash and urban yard clippings in municipal waste, energy crops (fast growing trees like poplars, willows, and grasses like switchgrass or elephant grass), and the methane captured from landfills, municipal waste water treatment, and manure from cattle or poultry, can also be used.
Biomass is considered to be one of the key renewable resources of the future at both small- and large-scale levels. It already supplies 14 % of the world's primary energy consumption. But for three quarters of the world's population living in developing countries biomass is the most important source of energy. With increases in population and per capita demand, and depletion of fossil-fuel resources, the demand for biomass is expected to increase rapidly in developing countries. On average, biomass produces 38 % of the primary energy in developing countries (90 % in some countries). Biomass is likely to remain an important global source in developing countries well into the next century.
Even in developed countries, biomass is being increasingly used. A number of developed countries use this source quite substantially, e.g. in Sweden and Austria 15 % of their primary energy consumption is covered by biomass. Sweden has plans to increase further use of biomass as it phases down nuclear and fossil-fuel plants into the next century.
In the USA , which derives 4 % of its total energy from biomass (nearly as much as it derives from nuclear power), now more than 9000 MW electrical power is installed in facilities firing biomass. But biomass could easily supply 20% more than 20 % of US energy consumption. In other words, due to the available land and agricultural infrastructure this country has, biomass could, sustainably, replace all of the power nuclear plants generate without a major impact on food prices. Furthermore, biomass used to produce ethanol could reduce also oil imports up to 50%.

BIOMASS - SOME BASIC DATA
* Total mass of living matter (including moisture) - 2000 billion tonnes
* Total mass in land plants - 1800 billion tonnes
* Total mass in forests -1600 billion tonnes
* Per capita terrestrial biomass - 400 tonnes
* Energy stored in terrestrial biomass 25 000 EJ
* Net annual production of terrestrial biomass - 400 000 million tonnes
* Rate of energy storage by land biomass - 3000 EJ/y (95 TW)
* Total consumption of all forms of energy - 400 EJ/y (12 TW)
* Biomass energy consumption - 55 EJ/y (1. 7 TW)

BIOMASS IN DEVELOPING COUNTRIES
Despite its wide use in developing countries, biomass energy is usually used so inefficiently that only a small percentage of its useful energy is obtained. The overall efficiency in traditional use is only about 5-15 per cent, and biomass is often less convenient to use compared with fossil fuels. It can also be a health hazard in some circumstances, for example, cooking stoves can release particulates, CO, NOx formaldehyde, and other organic compounds in poorly ventilated homes, often far exceeding recommended WHO levels. Furthermore, the traditional uses of biomass, i.e., burning of wood is often associated with the increasing scarcity of hand-gathered wood, nutrient depletion, and the problems of deforestation and desertification. In the early 1980s, almost 1.3 billion people met their fuelwood needs by depleting wood reserves.

Share of biomass on total energy consumption.
Nepal 95 %
Malawi 94 %
Kenya 75 %
India 50 %
China 33 %
Brazil 25 %
Egypt 20 %

There is an enormous biomass potential that can be tapped by improving the utilization of existing resources and by increasing plant productivity. Bioenergy can be modernized through the application of advanced technology to convert raw biomass into modern, easy-to-use carriers (such as electricity, liquid or gaseous fuels, or processed solid fuels). Therefore, much more useful energy could be extracted from biomass than at present. This could bring very significant social and economic benefits to both rural and urban areas. The present lack of access to convenient sources limits the quality of life of millions of people throughout the world, particularly in rural areas of developing countries. Growing biomass is a rural, labour-intensive activity, and can, therefore, create jobs in rural areas and help stem rural-to-urban migration, whilst, at the same time, providing convenient carriers to help promote other rural industries.

FOOD OR FUEL?
A major criticism often levelled against biomass, particularly against large-scale fuel production, is that it could divert agricultural production away from food crops, especially in developing countries. The basic argument is that energy-crop programmes compete with food crops in a number of ways (agricultural, rural investment, infrastructure, water, fertilizers, skilled labour etc.) and thus cause food shortages and price increases. However, this so-called “food versus fuel” controversy appears to have been exaggerated in many cases. The subject is far more complex than has generally been presented since agricultural and export policy and the politics of food availability are factors of far greater importance. The argument should be analysed against the background of the world’s (or an individual country’s or region’s) real food situation of food supply and demand (ever-increasing food surpluses in most industrialized and a number of developing countries), the use of food as animal feed, the under-utilized agricultural production potential, the increased potential for agricultural productivity, and the advantages and disadvantages of producing biofuels.
The food shortages and price increases that Brazil suffered a few years ago, were blamed on the ProAlcool programme. However, a closer examination does not support the view that bioethanol production has adversely affected food production since Brazil is one of the world’s largest exporters of agricultural commodities and agricultural production has kept ahead of population growth: in 1976 the production of cereals was 416 kg per capita, and in 1987 - 418 kg per capita. Of the 55 million ha of land area devoted to primary food crops, only 4.1 million ha (7.5 per cent) was used for sugarcane, which represents only 0.6 per cent of the total area registered for economic use (or 0.3 per cent of Brazil’s total area). Of this, only 1.7 million ha was used for ethanol production, so competition between food and crops is not significant. Furthermore, crop rotation in sugarcane areas has led to an increase in certain food crops, while some byproducts such as hydrolyzed bagasse and dry yeast are used as animal feed. Some experts (Goldemberg,1992) believe that “In fact, the potential for producing food in conjunction with

sugarcane appears to be larger than expected and should be explored further,". Food shortages and price increases in Brazil have resulted from a combination of policies which were biased towards commodity export crops and large acreage increases of such crops, hyper-inflation, currency devaluation, price control of domestic foodstuffs etc. Within this reality, any negative effects that bioethanol production might have had should be considered as part of the overall problem, not the problem.

It is important to mention that developing countries are facing both food and fuel problems. Adoption of agricultural practices should, therefore take into account this reality and evolve efficient methods of utilising available land and other resources to meet both food and fuel needs (besides other products), e.g., from agroforestry systems.

LAND AVAILABILITY

Biomass differs fundamentally from other forms of fuels since it requires land to grow on and is therefore subject to the range of independent factors which govern how, and by whom, that land should be used. There are basically two main approaches to deciding on land use for biomass. The "technocratic" approach starts from a need for, then identifies a biological source, the site to grow it, and then considers the possible environmental impacts. This approach generally had ignored many of the local and more remote side-effects of biomass plantations and also ignored the expertise of the local farmers who know the local conditions. This has resulted in many biomass project failures in the past. The "multi-uses" approach asks how land can best be used for sustainable development, and considers what mixture of land use and cropping patterns will make optimum use of a particular plot of land to meet multiple objectives of food, fuel, fodder, societal needs etc. This requires a full understanding of the complexity of land use.

Generally it can be said that biomass productivity can be improved since in many place of the world is low, being much less than 5 t/ha/yr. for woody species without good management. Increased productivity is the key to both providing competitive costs and better utilisation of available land. Advances have included the identification of fast-growing species, breeding successes and multiple species opportunities, new physiological knowledge of plant growth processes, and manipulation of plants through biotechnology applications, which could raise productivity 5 to 10 times over natural growth rates in plants or trees.

It is now possible with good management, research, and planting of selected species and clones on appropriate soils to obtain 10 to 15 t/ha/yr. in temperate areas and 15 to 25 t/ha/yr. in tropical countries. Record yields of 40 t/ha/yr. (dry weight) have been obtained with eucalyptus in Brazil and Ethiopia. High yields are also feasible with herbaceous (non-woody) crops where the agro-ecological conditions are suitable. For example, in Brazil, the average yield of sugarcane has risen from 47 to 65 t/ha (harvested weight) over the last 15 years while over 100t/ha/yr are common in a number of areas such as Hawaii, South Africa, and Queensland in Australia. It should be possible with various types of biomass production to emulate the three-fold increase in grain yields which have been achieved over the past 45 years although this would require the same high levels of inputs and infrastructure development. However, in trials in Hawaii, yields of 25 t/ha/yr. have been achieved without nitrogen fertilizers when eucalyptus is interplanted with nitrogen fixing Albizia trees (De Bell et al, 1989).

3.2 ENERGY VALUE

Biomass (when considering its energy potential) refers to all forms of plant-derived material that can be used for energy: wood, herbaceous plants, crop and forest residues, animal wastes etc.

Because biomass is a solid fuel it can be compared to coal. On a dry-weight basis, heating values range from 17,5 GJ per tonne for various herbaceous crops like wheat straw, sugarcane bagasse to about 20 GJ/tonne for wood. The corresponding values for bituminous coals and lignite are 30 GJ/tonne and 20 GJ/tonne respectively (see tables at the end). At the time of its harvest biomass contains considerable amount of moisture, ranging from 8 to 20 % for wheat straw, to 30 to 60 % for woods, to 75 to 90 % for animal manure, and to 95 % for water hyacinth. In contrast the moisture content of the most bituminous coals ranges from 2 to 12 %. Thus the energy density for the biomass at the point of production are lower than those for coal. On the other side chemical attributes make it superior in many ways. The ash content of biomass is much lower than for coals, and the ash is generally free of the toxic metals and other contaminants and can be used as soil fertiliser.
Biomass is generally and wrongly regarded as a low-status fuel, and in many countries rarely finds its way into statistics. It offers considerable flexibility of fuel supply due to the range and diversity of fuels which can be produced. Biomass energy can be used to generate heat and electricity through direct combustion in modern devices, ranging from very-small-scale domestic boilers to multi-megawatt size power plants electricity (e.g. via gas turbines), or liquid fuels for motor vehicles such as ethanol, or other alcohol fuels. Biomass-energy systems can increase economic development without contributing to the greenhouse effect since biomass is not a net emitter of CO2 to the atmosphere when it is produced and used sustainably. It also has other benign environmental attributes such as lower sulphur and NOx emissions and can help rehabilitate degraded lands. There is a growing recognition that the use of biomass in larger commercial systems based on sustainable, already accumulated resources and residues can help improve natural resource management.

Energy contents comparison table.

	Content of water %	MJ/kg	KW/kg
Oak- tree	20	14,1	3,9
Pine-tree	20	13,8	3,8
Straw	15	14,3	3,9
Grain	15	14,2	3,9
Rape oil	-	37,1	10,3
Hard coal	4	30,0-35,0	8,3
Brown coal	20	10,0-20,0	5,5
Heating oil	-	42,7	11,9
Bio methanol	-	19,5	5,4

	MJ/Nm3	KWh/Nm3
Sewer gas	16,0	4,4
Wood gas	5,0	1,4
Biogas from cattle dung	22,0	6,1
Natural gas	31,7	8,8

Hydrogen	10,8	3,0

3.3 BENEFITS OF BIOMASS AS ENERGY SOURCE

Rural economic development in both developed and developing countries is one of the major benefits of biomass. Increase in farm income and market diversification, reduction of agricultural commodity surpluses and derived support payments, enhancement of international competitiveness, revitalization of retarded rural economies, reduction of negative environmental impacts are most important issues related to utilisation of biomass as energy source. The new incomes for farmers and rural population improve the material welfare of rural communities and this might result in a further activation of the local economy. In the end, this will mean a reduction in the emigration rates to urban environments, which is very important in many areas of the world. The number of jobs created (for production, harvesting and use) and the industrial growth (from developing conversion facilities for fuel, industrial feedstocks, and power) would be enormous. For instance, the U.S. Department of Agriculture estimates that 17,000 jobs are created per every million of gallons of ethanol produced, and the Electric Power Research Institute has estimated that producing 5 quadrillion Btu's (British Thermal Units) of electricity on 50 million acres of land would increase overall farm income by $12 billion annually (the U.S. consumes about 90 quadrillion Btu's annually). By providing farmers with stable income, these new markets diversify and strengthen the local economy by keeping income recycling through the community. Improvement in agricultural resource utilisation has been frequently proposed in EU. The development of alternative markets for agricultural products might result in more productive uses of the cropland, currently under-utilised in many EU countries. In 1991, the EU planted 128 million ha of land to crops. Approximately 0,8 million ha were removed from production under the set aside program. A much greater amount is planned to remain idled in future. It is clear that reorientation of some of these lands to non-food utilisation (like biomass for energy) might avoid misallocation of agricultural resources. European agriculture relies on the production of a limited number of crops, mainly used for human and livestock food, many of which are at present on surplus production. Reduced prices have resulted in low and variable income for many EU farmers. The cultivation of energy crops could reduce surpluses. New energy crops may be more economically competitive than crops in surplus production.

3.4 ENVIRONMENTAL BENEFITS

The use of biomass energy has many unique qualities that provide environmental benefits. It can help mitigate climate change, reduce acid rain, soil erosion, water pollution and pressure on landfills, provide wildlife habitat, and help maintain forest health through better management.

3.4.1 CLIMATE CHANGE

Climate change is a growing concern world-wide. Human activity, primarily through the combustion of fossil fuels, has released hundreds of millions of tons of so-called 'greenhouse gases' (GHGs) into the atmosphere. GHGs include such gases as carbon dioxide (CO2) and methane (CH4). The concern is that all of the greenhouse gases in the atmosphere will change the Earth's climate, disrupting the entire biosphere which currently supports life as we know it. Biomass energy technologies can help minimize this concern. Although both methane and carbon dioxide pose significant threats, CH4 is 20 times more potent (though shorter-lived in the atmosphere) than CO2. Capturing methane from landfills, wastewater treatment, and manure lagoons prevents the methane from being vented to the atmosphere and allows the energy to be used to generate electricity or power motor vehicles. All crops, including biomass energy crops,

sequester carbon in the plant and roots while they grow, providing a carbon sink. In other words, the carbon dioxide released while burning biomass is absorbed by the next crop growing. This is called a closed carbon cycle. In fact, the amount of carbon sequestered may be greater than that released by combustion because most energy crops are perennials, they are harvested by cutting rather than uprooting. Thus the roots remain to stabilize the soil, sequester carbon and to regenerate the following year.

3.4.2 ACID RAIN

Acid rain is caused primarily by the release of sulphur and nitrogen oxides from the combustion of fuels. Acid rain has been implicated in the killing of lakes, as well as impacting humans and wildlife in other ways. Since biomass has no sulphur content, and easily mixes with coal, "co-firing" is a very simple way of reducing sulphur emissions and thus, reduce acid rain. "Co-firing" refers to burning biomass jointly with coal in a traditionally coal-fired power plant or heating plant.

3.4.3 SOIL EROSION & WATER POLLUTION

Biomass crops can reduce water pollution in a number of ways. Energy crops can be grown on more marginal lands, in floodplains, and in between annual crops areas. In all these cases, the crops stabilize the soil, thus reducing soil erosion. They also reduce nutrient run-off, which protects aquatic ecosystems. Their shade can even enhance the habitat for numerous aquatic organisms like fish. Furthermore, because energy crops tend to be perennials, they do not have to be planted every year. Since farm machinery spends less time going over the field, less soil compaction and soil disruption takes place. Another way biomass energy can reduce water pollution is by capturing the methane, through anaerobic digestion, from manure lagoons on cattle, hog and poultry farms. These enormous lagoons have been responsible for polluting rivers and streams across the country. By utilizing anaerobic digesters, the farmers can reduce odour, capture the methane for energy, and create either liquid or semi-solid soil fertilisers which can be used on-site or sold.

3.5 BIOMASS FUELS

Plants are the most common source of biomass. They have been used in the form of wood, peat and straw for thousands of years. Today the western world is far less reliant on this high energy fuel. This is because of the general acceptance that coal, oil and electricity are cleaner, more efficient and more in keeping with modernisation and technology. However this is not really the right impression. Plants can either be specially grown for energy production, or they can be harvested from the natural environment. Plantations tend to use breeds of plant that are to produce a lot of biomass quickly in a sustainable fashion. These could be trees (e.g. willows or Eucalyptus) or other high growth rate plants (such as sugar cane or maize or soybean).

3.5.1 WOOD RESIDUES

Wood can be, and usually is, removed sustainably from existing forests world-wide by using methods such as coppicing. It is difficult to estimate the mean annual increment (growth) of the world's forests. One rough estimate is 12,5x109 m3/yr with an content of 182 EJ equivalent to 1,3 times the total world coal consumption. The estimated global average annual wood harvests in the period 1985-1987 were 3,4x 109 m3/yr (equivalent to 40 EJ/yr.), so some of the unused increment could be recovered for energy purposes while maintaining or possibly even enhancing the

productivity of forests.
Operations such as thinning of plantations and trimming of felled trees generate large volumes of forestry residues. At present these are often left to rot on site - even in countries with fuelwood shortages. They can be collected, dried and used as fuel by nearby rural industry and domestic consumers, but their bulk and high water content makes transporting them for wider use uneconomic. In developing countries where charcoal is an important fuel, on-site kilns can reduce transport costs. Mechanical harvesters and chippers have been developed in Europe and North America over the last 15 years to produce uniform 30-40 mm wood chips which can be handled, dried and burned easily in chip-fired boilers. The use of forest residues to produce steam for heating and/or power generation is now a growing business in many countries. American electricity utilities have more than 9 000 MW (output of 9 nuclear power plants) of biomass-fired generating plant on line, much of it constructed in the last ten years. Austria has about 1250 MW of wood-fired heating capacity in the form of domestic stoves and district heating plant, burning waste wood, bark and wood chips. Most of these district heating systems are of 1-2 MW capacity, with a few larger units (around15 MW) and a number of small-scale CHP systems.
Timber processing is a further source of wood residues. Dry sawdust and waste produced during the processing of cut timber make very good fuel. The British furniture industry is estimated to use 35 000 tonnes of such residues a year, one third of its production, providing 0,5 PJ of space and water heating and process heat (FOE, 1991). In Sweden, where biomass already provides nearly 15% of primary energy, forestry residues and wood industries contribute over 200 PJ/yr., mainly as fuel for CHP plant.

3.5.2 AGRICULTURAL RESIDUES

Agricultural waste is a potentially huge source of biomass. Crop and animal wastes provide significant amounts of energy coming second only to wood as the dominant biomass fuel world-wide. Waste from agriculture includes: the portions of crop plants discarded like straw, whether damaged or surplus supplies, and animal dung. It was estimated, for example, that 110 Mt of dung and crop residues were used as fuel in India in 1985, compared with 133 Mt of wood, and in China the mass of available agricultural residues has been estimated at 2.2 times the mass of wood fuel.
Every year, millions tonnes of straw are produced world-wide with usually half of it surplus to need. In many countries this is still being burned in the field or ploughed back into the soil, but in some developed countries environmental legislation which restrict field burning has drawn attention to its potential as an energy resource
Effort to remove crop residues from soils and to use them for energy purposes leads to a central question: how much residue should be left and recycled into soil to sustain production of biomass ? According to the experience from developed countries around 35% of crop residues can be removed from soil without adverse effects on future plant production.
Industrial waste that contains biomass may be used to produce energy. For example the sludge left after alcohol production (known as vinasse) can produce flammable gas. Other useful waste products include, waste from food processing and fluff from the cotton and textiles industry.

3.5.3 SHORT ROTATION PLANTS

Biomass can be also be produced by so-called short-rotation plantation of trees and other plants like grasses (sorghum, sugarcane, switchgrass). All these plants can be used as fuels like wood with the main advantage of their short span between plantation and harvesting – typically between

three and eight years. For some grasses harvesting is taking place every six to 12 months. Recently there are about 100 million hectares of land utilised for tree plantation world-wide. Most of these trees are used for forest products markets.

Parameters which are important in evaluating species for short rotation plants include availability of planting stock, ease of propagation, survival ability under adverse conditions and the yield potential measured as dry matter production per hectare per year (t/ha/y). Yield is a measure of a plant's ability to utilize the site resources. It is the most important factor when considering biomass production due to the need to optimize/maximize yield from a given area of land within a given time frame at the least possible cost. High yielding species are therefore preferred for biomass energy systems.

Some plant communities have shown superiority in dry matter production compared to others grown under similar conditions. Although reported dry matter production of different tree species varies over a wide range depending on soil types and climate, certain species stand out. For Eucalyptus species, yields of up to 65 t/ha/y have been reported, compared to 30 and 43 t/ha/y in Salix and Populus species respectively.

Despite the fact that biomass plantation can be of great importance for most developed countries experience has shown it is unlikely to be established on a large scale in many developing countries, especially in poor rural areas, so long as biofuels (particularly wood) can be obtained at zero or near zero cost.

3.6 BIOMASS FUELS IN DEVELOPING COUNTRIES

3.6.1 Fuelwood

The term fuelwood describe all types of fuels derived from forestry and plantation. Fuelwood accounts for about 10 per cent of the total used in the world. It provides about 20 % of all used in Asia and Latin America, and about 50 % of total used in Africa. However, it is the major source of, in particular for domestic purposes, in poor developing countries: in 22 countries, fuelwood accounted for 25 to 49 %, in 17 countries, 50-74 %, and in 26 countries, 75-100 % of their respective national consumption.

More than half of the total wood harvested in the world is used as fuelwood. For specific countries, for example in Tanzania, the contribution can be as high as 97% . Although fuelwood is the major source of for most rural and low-income people in the developing world, the potential supply of fuelwood is dwindling rapidly, leading to scarcity of and environmental degradation. It is estimated that, for more than a third of the world population, the real crisis is the daily scramble to obtain fuelwood to meet domestic use.

Several studies on fuelwood supply in developing countries have concluded that fuelwood scarcities are real and will continue to exist, unless appropriate approaches to resource management are undertaken. The increase of fuelwood production through efficient techniques, can, therefore, be considered as one of the major pre-requisites for attaining sustainable development in developing countries.

3.6.2 Charcoal

The main expansion in the use of charcoal in Europe came with the industrial revolution in England in the 17th and 18th centuries. In Sweden, charcoal consumption for iron making grew through most of the 19th century, and was the basis of the good quality tradition of Swedish steel. Today charcoal is an important household fuel and to a lesser extent, industrial fuel in many developing countries. It is mainly used in the urban areas where its ease of storage, high content

(30 MJ/kg as compared with 15 MJ/kg in fuelwood), lower levels of smoke emissions, and, resistance to insect attacks make it more attractive than fuelwood. In the United Republic of Tanzania, charcoal accounts for an estimated 90 per cent of biofuels consumed in urban centres.

3.6.3 Residues

Agricultural residues have an enormous potential for production. In favourable circumstances, biomass power generation could be significant given the vast quantities of existing forestry and agricultural residues - over 2 billion t/yr. world-wide. This potential is currently under-utilized in many areas of the world. In wood-scarce areas, such as Bangladesh, China, the northern plains of India, and Pakistan, as much as 90 per cent of household in many villages covers their energy needs with agricultural residues. It has been estimated that about 800 million people world-wide rely on agricultural residues and dung for cooking, although reliable figures are difficult to obtain. Contrary to the general belief, the use of animal manure as an source is not confined to developing countries alone, e.g., in California a commercial plant generates about 17.5 MW of electricity from cattle manure, and a number of plants are operating in the Europe.

There is 54 EJ of biomass energy theoretically available from recoverable residues in developing countries and 42 EJ in industrialized regions. The amount of potentially recoverable residues includes the three main sources: forestry, crops and dung. The calculations assume only 25 per cent of the potentially harvestable residues are likely to be used. Developing countries could theoretically derive 15 per cent of present energy consumption from this source and industrialized countries could derive 4 per cent.

Sugarcane residues (bagasse, and leaves) - are particularly important and offer an enormous potential for generation of electricity. Generally, residues are still used very inefficiently for electricity production, in many cases deliberately to prevent their accumulation, but also because of lack of technical and financial capabilities in developing countries.

Depending on the choice of the gas turbine technology and the extent to which cane tops and leaves can be used for off-season generation, according to some estimates (Williams 1989) amount of electricity that can be produced from cane residues could be up to 44 times the on-site needs of the sugar factory or alcohol distillery. For each litre of alcohol produced a BIG/STIG unit would be able to produce more than 11 kWh of electricity in excess of the distillery's needs (about 820 kWh/t). Another estimate of bagasse in condensing-extraction steam turbines puts the surplus electricity values at 20-65 kWh per ton of cane, and this surplus could be doubled by using barbojo for generation during the off-season. The cost of the generated electricity is estimated to be about $US 0.05/kWh. Revenues from the sale of electricity co-produced with sugar could be comparable with sugar revenues, or alternatively, revenues from the sale of electricity co-produced with ethanol could be much greater than the alcohol revenues. In the latter instance, electricity would become the primary product of sugarcane, and alcohol the by-product.

In India alone, electricity production from sugarcane residues by the year 2030 could be up to 550 TWh/year (the total electricity production from all sources in 1987 was less than 220 TWh (Ogden et al, 1990). Globally, it has been estimated that about 50,000 MW could be supported by currently produced residues. The theoretical potential of residues in the 80 sugarcane-producing developing countries could be up to 2800 TWh/yr., which is about 70 per cent more than the total electricity production of these countries from all sources in 1987. Studies of the sugarcane industry indicate a combined power capability in excess of 500 TWh/yr. Assuming that a third of the global residue resources could economically and sustainably be recovered by new energy technology, 10 per cent

of the current global electricity demand (10.000 TWh/yr.) could be generated.
Obviously, to achieving such goals, these are theoretical calculations with country- and site specific problems. They do however emphasize the potential which many countries have to provide a substantial proportion of their from biomass grown on a sustainable basis.

3.7 METHODS OF GENERATING ENERGY FROM BIOMASS

Nearly all types of raw biomass decompose rather quickly, so few are very good long-term energy stores; and because of their relatively low energy densities, they are likely to be rather expensive to transport over appreciable distances. Recent years have therefore seen considerable effort devoted to the search for the best ways to use these potentially valuable sources of energy.
In considering the methods for extracting the energy, it is possible to order them by the complexity of the processes involved:
* Direct combustion of biomass.
* Thermochemical processing to upgrade the biofuel. Processes in this category include pyrolysis, gasification and liquefaction.
* Biological processing. Natural processes such as anaerobic digestion and fermentation which lead to a useful gaseous or liquid fuel.

The immediate ‘product, of some of these processes is heat - normally used at place of production or at not too great a distance, for chemical processing or district heating, or to generate steam for power production. For other processes the product is a solid, liquid or gaseous fuel: charcoal, liquid fuel as a petrol substitute or additive, gas for sale or for power generation using either steam or gas turbines.

3.7.1 COMBUSTION

The technology of direct combustion as the most obvious way of extracting energy from biomass is well understood, straightforward and commercially available. Combustion systems come in a wide range of shapes and sizes burning virtually any kind of fuel, from chicken manure and straw bales to tree trunks, municipal refuse and scrap tyres. Some of the ways in which heat from burning wastes is currently used include space and water heating, industrial processing and electricity generation. One problem with this method is its very low efficiency. With an open fire most of the heat is wasted and is not used to cook or whatever.
Combustion of wood can be divided into four phases:
* Water inside the wood boils off. Even wood that has been dried for ages has as much as 15 to 20% of water in its cell structure.
* Gas content is freed from the wood. It is vital that these gases should burn and not just disappear up the chimney.
* The gases emitted mix with atmospheric air and burn at a high temperature.
* The rest of the wood (mostly carbon) burns. In perfect combustion the entire energy is utilised and all that is left is a little pile of ashes.

Three things are needed for effective burning:
* high enough temperatures;
* enough air, and
* enough time for full combustion.

If not enough air gets in, combustion is incomplete and the smoke is black from the unburned

carbon. It smells terrible, and you get soot deposited in the chimney, with the risk of fire. If too much air gets in the temperature drops and the gases escape unburned, taking the heat with them. The right amount of air gives the best utilisation of fuel. No smell, no smoke, and very little risk of chimney fires. Regulation of the air supply depends largely on the chimney and the draught it can put up.

Direct combustion is the simplest and most common method of capturing the energy contained within biomass. Boiling a pan of water over a wood fire is a simple process. Unfortunately, it is also very inefficient, as a little elementary calculation reveals.

The energy content of a cubic metre dry wood is 10 GJ, which is ten million kJ. To raise the temperature of a litre of water by 1 degree Celsius requires 4,2 kJ of heat energy. Bringing a litre to the boil should therefore require rather less than 400 kJ, equivalent to 40 cubic centimetres of wood - one small stick, perhaps. In practice, with a simple open fire we might need at least fifty times this amount: a conversion efficiency no better than 2%.

Designing a stove or boiler which will make rather better use of valuable fuel requires an understanding of the processes involved in the combustion of a solid fuel. The first is one which consumes rather than produces energy: the evaporation of any water in the fuel. With reasonably dry fuel, however, this uses only a few percent of the total energy. In the combustion process itself there are always two stages, because any solid fuel contains two combustible constituents. The volatile matter is released as a mixture of vapours or vaporised tars and oils by the fuel as its temperature rises. The combustion of these produces the little spurts of pyrolysis.

Modern combustion facilities (boilers) usually produce heat, steam (used in industrial process) or electricity. Direct combustion systems vary considerably in their design. The fuel choice makes a difference in the design and efficiency of the combustion system. Direct combustion technology using biomass as the fuel is very similar to that used for coal. Biomass and coal can be handled and burned in essentially the same fashion. In fact, biomass can be “co-fired” with coal in small percentages in existing boilers. The biomass which is co-fired are usually low-cost feedstocks, like wood or agricultural waste, which also help to reduce the emissions typically associated with coal. Coal is simply fossilized biomass heated and compressed over millions of years. The process which coal undergoes as it is heated and compressed deep within the earth, adds elements like sulphur and mercury to the coal. Burning coal for heat or electricity releases these elements, which biomass does not contain.

3.7.2 PYROLYSIS

Pyrolysis is the simplest and almost certainly the oldest method of processing one fuel in order to produce a better one. A wide range of energy-rich fuels can be produced by roasting dry wood or even the straw. The process has been used for centuries to produce charcoal. Conventional pyrolysis involves heating the original material (which is often pulverised or shredded then fed into a reactor vessel) in the near-absence of air, typically at 300 - 500 °C, until the volatile matter has been driven off. The residue is then the char - more commonly known as charcoal - a fuel which has about twice the energy density of the original and burns at a much higher temperature. For many centuries, and in much of the world still today, charcoal is produced by pyrolysis of wood. Depending on the moisture content and the efficiency of the process, 4-10 tonnes of wood are required to produce one tonne of charcoal, and if no attempt is made to collect the volatile matter, the charcoal is obtained at the cost of perhaps two-thirds of the original energy content. Pyrolysis can also be carried out in the presence of a small quantity of oxygen (‘gasification’), water (‘steam gasification’) or hydrogen (‘hydrogenation’). One of the most useful products is

methane, which is a suitable fuel for electricity generation using high-efficiency gas turbines. With more sophisticated pyrolysis techniques, the volatiles can be collected, and careful choice of the temperature at which the process takes place allows control of their composition. The liquid product has potential as fuel oil, but is contaminated with acids and must be treated before use. Fast pyrolysis of plant material, such as wood or nutshells, at temperatures of 800-900 degrees Celsius leaves as little as 10% of the material as solid char and converts some 60% into a gas rich in hydrogen and carbon monoxide. This makes fast pyrolysis a competitor with conventional gasification methods (see bellow), but like the latter, it has yet to be developed as a treatment for biomass on a commercial scale.

At present, conventional pyrolysis is considered the more attractive technology. The relatively low temperatures mean that fewer potential pollutants are emitted than in full combustion, giving pyrolysis an environmental advantage in dealing with certain wastes. There have been some trials with small-scale pyrolysis plants treating wastes from the plastics industry and also used tyres - a disposal problem of increasingly urgent concern.

3.7.3 GASIFICATION

The basic principles of gasification have been under study and development since the early nineteenth century, and during the Second World War nearly a million biomass gasifier-powered vehicles were used in Europe. Interest in biomass gasification was revived during the “energy crisis” of the 1970s and slumped again with the subsequent decline of oil prices in the 1980s. The World Bank (1989) estimated that only 1000 - 3000 gasifiers have been installed globally, mostly small charcoal gasifiers in South America.

Gasification based on wood as a fuel produces a flammable gas mixture of hydrogen, carbon monoxide, methane and other non flammable by products. This is done by partially burning and partially heating the biomass (using the heat from the limited burning) in the presence of charcoal (a natural by-product of burning biomass). The gas can be used instead of petrol and reduces the power output of the car by 40%. It is also possible that in the future this fuel could be a major source of energy for power stations.

SYNTHETIC FUELS

A gasifier which uses oxygen rather than air can produce a gas consisting mainly of H2, CO and C02, and the interesting potential of this lies in the fact that removal of the C02 leaves the mixture called synthesis gas, from which almost any hydrocarbon compound may be synthesised. Reacting the H2 and CO is one way to produce pure methane. Another possible product is methanol (CH3OH), a liquid hydrocarbon with an energy density of 23 GJ per tonne. Producing methanol in this way involves a series of sophisticated chemical processes with high temperatures and pressures and expensive plant, and one might wonder why it is of interest. The answer lies in the product: methanol is that valuable commodity, a liquid fuel which is a direct substitute for gasoline. At present the production of methanol using synthesis gas from biomass is not a commercial proposition, but the technology already exists, having been developed for use with coal as feedstock - as a precaution by coal-rich countries at times when their oil supplies were threatened.

3.7.4 FERMENTATION

Fermentation of sugar solution is the way how ethanol (ethyl alcohol) can be produced. Ethanol is a very high liquid energy fuel which can be used as the substitute for gasoline in cars. This fuel is used successfully in Brazil. Suitable feedstocks include crushed sugar beet or fruit. Sugars can also

be manufactured from vegetable starches and cellulose by pulping and cooking, or from cellulose by milling and treatment with hot acid. After about 30 hours of fermentation, the brew contains 6-10 per cent alcohol, which can be removed by distillation as a fuel.

Fermentation is an anaerobic biological process in which sugars are converted to alcohol by the action of micro-organisms, usually yeast. The resulting alcohol is ethanol (C2H3OH) rather than methanol (CH3OH), but it too can be used in internal combustion engines, either directly in suitably modified engines or as a gasoline extender in gasohol: gasoline (petrol) containing up to 20% ethanol.

The value of any particular type of biomass as feedstock for fermentation depends on the ease with which it can be converted to sugars. The best known source of ethanol is sugar-cane - or the molasses remaining after the cane juice has been extracted. Other plants whose main carbohydrate is starch (potatoes, corn and other grains) require processing to convert the starch to sugar. This is commonly carried out, as in the production of some alcoholic drinks, by enzymes in malts. Even wood can act as feedstock, but its carbohydrate, cellulose, is resistant to breakdown into sugars by acid or enzymes (even in finely divided forms such as sawdust), adding further complication to the process.

The liquid resulting from fermentation contains only about 10% ethanol, which must be distilled off before it can be used as fuel. The energy content of the final product is about 30 GJ/t, or 24 GJ/m3. The complete process requires a considerable amount of heat, which is usually supplied by crop residues (e.g. sugar cane bagasse or maize stalks and cobs). The energy loss in fermentation is substantial, but this may be compensated for by the convenience and transportability of the liquid fuel, and by the comparatively low cost and familiarity of the technology.

3.7.5 ANAEROBIC DIGESTION

Nature has a provision of destroying and disposing of wastes and dead plants and animals. Tiny micro-organisms called bacteria carry out this decay or decomposition. The farmyard manure and compost is also obtained through decomposition of organic matter. When a heap of vegetable or animal matter and weeds etc. die or decompose at the bottom of back water or shallow lagoons then the bubbles can be noticed rising to the surface of water. Some times these bubbles burn with flame at dusk. This phenomenon was noticed for ages, which puzzled man for a long time. It was only during the last 200 years or so when scientists unlocked this secret, as the decomposition process that takes place under the absence of air (oxygen). This gas, production of which was first noticed in marshy places, was and is still called as ‘Marsh Gas’. It is now well known that this gas (Marsh Gas) is a mixture of Methane (CH4) and Carbon dioxide (CO2) and is commonly called as the ‘Biogas’. As per records biogas was first discovered by Alessandro Volta in 1776 and Humphery Davy was the first to pronounce the presence of combustible gas Methane in the Farmyard Manure in as early as 1800. The technology of scientifically harnessing this gas from any biodegradable material (organic matter) under artificially created conditions is known as biogas technology.

Anaerobic digestion, like pyrolysis, occurs in the absence of air; but in this case the decomposition is caused by bacterial action rather than high temperatures. It is a process which takes place in almost any biological material, but is favoured by warm, wet and of course airless conditions. It occurs naturally in decaying vegetation on the bottom of ponds, producing the marsh gas which bubbles to the surface and can even catch fire.

Anaerobic digestion also occurs in situations created by human activities. One is the biogas which is generated in concentrations of sewage or animal manure, and the other is the landfill gas

produced by domestic refuse buried in landfill sites. In both cases the resulting gas is a mixture consisting mainly of methane and carbon dioxide; but major differences in the nature of the input, the scale of the plant and the time-scale for gas production lead to very different technologies for dealing with the two sources.
The detailed chemistry of the production of biogas and landfill gas is complex, but it appears that a mixed population of bacteria breaks down the organic material into sugars and then into various acids which are decomposed to produce the final gas, leaving an inert residue whose composition depends on the type of system and the original feedstock.

3.7.5.1 Biogas
is a valuable fuel which is in many countries produced in purpose built digesters filled with the feedstock like dung or sewage. Digesters range in size from one cubic metre for a small 'household' unit to more than thousand cubic meters used in large commercial installation or farm plants. The input may be continuous or in batches, and digestion is allowed to continue for a period of from ten days to a few weeks. The bacterial action itself generates heat, but in cold climates additional heat is normally required to maintain the ideal process temperature of at least 35 degrees Celsius, and this must be provided from the biogas. In extreme cases all the gas may be used for this purpose, but although the net energy output is then zero, the plant may still pay for itself through the saving in fossil fuel which would have been needed to process the wastes. A well-run digester will produce 200-400 m3 of biogas with a methane content of 50% to 75% for each dry tonne of input.
LANDFILL GAS
A large proportion of ordinary domestic refuse - municipal solid wastes - is biological material and its disposal in landfills creates suitable conditions for anaerobic digestion. That landfill sites produce methane has been known for decades, and recognition of the potential hazard led to the fitting of systems for burning it off; however, it was only in the 1970s that serious attention was paid to the idea of using this 'undesirable' product.
The waste matter is more miscellaneous in a landfill than in a biogas digester, and the conditions neither as warm nor as wet, so the process is much slower, taking place over years rather than weeks. The end product, known as landfill gas, is again a mixture consisting mainly of CH4 and CO2. In theory, the lifetime yield of a good site should lie in the range 150-300 m3 of gas per tonne of wastes, with between 50% and 60% by volume of methane. This suggests a total energy of 5-6 GJ per tonne of refuse, but in practice yields are much less.
In developing a site, each area is covered with a layer of impervious clay or similar material after it is filled, producing an environment which encourages anaerobic digestion. The gas is collected by an array of interconnected perforated pipes buried at depths up to 20 metres in the refuse. In new sites this pipe system is constructed before the wastes start to arrive, and in a large well-established landfill there can be several miles of pipes, with as much as 1000 m3 an hour of gas being pumped out.
Increasingly, the gas from landfill sites is used for power generation. At present most plants are based on large internal combustion engines, such as standard marine engines. Driving 500 kW generators, these are well matched to typical gas supply rates of the order of 10 GJ an hour.

3.8 TECHNOLOGY EXAMPLES
3.8.1 Heat production with wood firing boilers
Most common process of biomass combustion is burning of wood. In developed countries

replacing oil or coal-fired central heating boiler with a wood burning one can save between 20 and 60% on heating bills, because wood costs less than oil or coal. At the same time wood burning units are eco-friendly. They only emit the same amount of the greenhouse gas CO2 as the tree absorbed when it was growing. So burning wood does not contribute to global warming. Since wood contains less sulphur than oil does, less sulphate is discharged into the atmosphere. This means less acid rain and less acid in the environment.

SMALL BOILERS

Small wood burning boilers are frequently used for heating houses. There are approx. 70,000 small boilers burning firewood, wood chips, or wood pellets in Denmark alone. Such a boiler gives off its heat to radiators in exactly the same way as e.g. an oil-fired one. In this it differs from a wood burning stove, which only gives off its heat to the room it is in. In other words a wood burning boiler can heat whole house and provide hot water. For a single family home, a hand-fired wood burning boiler is usually the best and most economical investment. In larger places such as farms the saving from burning wood is often so great that it pays to install an automatic stoker unit burning wood pellets.

Many of small boilers are manually fired with storage tank for wood. Distinctions should be made between manually fired boilers for fuelwood and automatically fired boilers for wood chips and wood pellets. Manually fired boilers are installed with storage tank so as to accumulate the heat energy from fuel. Automatic boilers are equipped with a silo containing wood pellets or wood chips. A screw feeder feeds the fuel simultaneously with the output demand of the dwelling. Great advances have been made over the recent 10 years for both boiler types in respect of higher efficiency and reduced emission from the chimney (dust and carbon monoxide). Improvements have been achieved particularly in respect of the design of combustion chamber, combustion air supply, and the automatics controlling the process of combustion. In the field of manually fired boilers, an increase in the efficiency has been achieved from below 50% to 75-90%. For the automatically fired boilers, an increase in the efficiency from60% to 85-92% has been achieved.

MANUALLY FIRED BOILERS

The principal rule is that manually fired boilers for fuelwood only have an acceptable combustion at the boiler rated output (at full load). At individual plants with oxygen control, the load can, however, be reduced to approx. 50% of the nominal output without thereby influencing neither the efficiency nor emissions. By oxygen control, a lambda probe measures the oxygen content in the flue gas, and the automatic boiler control varies the combustion air inlet.

The same system is used in cars. In order for the boiler not to need feeding at intervals of 2-4 hours a day, during the coldest periods of the year, the fuelwood boiler nominal output is selected so as to be up to 2-3 times the output demand of the dwelling. This means that the boiler efficiency figures shown in Figure 15 and 16 should be multiplied by 2 or 3 in the case of manually fired boilers. Boilers designed for fuelwood should always be equipped with storage tank. This ensures both the greatest comfort for the user and the least financial and environmental strain. In case of no storage tank, an increased corrosion of the boiler is often seen due to variations in water and flue gas temperatures.

AUTOMATICALLY FIRED BOILERS

Despite an often simple construction, most of the automatically fired boilers can achieve an efficiency of 80-90% and a CO emission of approx. 100 ppm (100 ppm = 0.01 volume %). For some boilers, the figures are 92% and 20 ppm, respectively. An important condition for achieving

these good results is that the boiler efficiency during day-to-day operation is close to full load. For automatic boilers, it is of great importance that the boiler nominal output (at full load) does not exceed the max. output demand in winter periods. In the transition periods (3-5 months) spring and autumn, the output demand of the dwelling will typically be approx. 20-40% of the boiler nominal output, which means a deteriorated operating result. During the summer period, the output demand of the dwelling will often be in the range of 1-3 kW, since only the hot water supply will be maintained. This equals 5 -10% of the boiler nominal output. This operating method reduces the efficiency - typically 20-30% lower than that of the nominal output - and an increased negative effect on the environment. The alternative to the deteriorated summer operating is to combine the installation with a storage tank and solar collectors.

3.8.2 MANUALLY-FIRED BOILERS

BURN-THROUGH

Nearly all old-fashioned cast iron stoves act on the burn-through principle: air comes in from below and passes upwards through the fuel. In burn-through boilers the wood burns very quickly. The gases do not burn very well, since the boiler temperature is low. Most of the gas goes up the chimney, and the energy with it. The flue gases have a very short space in which to give off their heat to the boiler in the convection section. By and large, burn-through furnaces are unsuitable for wood. The useful effect of a burn-through boiler is typically under 50%.

UNDERBURN BOILERS

Underburn boiler is very different from a burn-through one. The air is not drawn through all the fuel at once, but only through part of it. Only the bottom layer of wood burns; the rest dries out and gives off its gases very slowly. Adding extra air (so-called “secondary air”) direct to the flames burns the gases more effectively. In modern underburning boilers the combustion chamber is ceramic lined, which insulates well and keeps the heat in. This gives a high temperature of combustion, burning the gases most effectively. An underburning boiler typically has a useful effect of 65-75%.

REVERSE COMBUSTION BOILERS

In reverse combustion too, air is only added to part of the fuel. As in underburning, the gases leave the fuel slowly and are burnt efficiently. Secondary air is also led into an earthenware-lined chamber, giving a high temperature of combustion. The flue gas has to pass through the entire boiler, giving it plenty of time to give up its heat. The useful effect is typically of the order of 75-85%. Some reverse combustion boilers have a blower instead of natural draught. Such boilers often have slightly better combustion, with less soot and pollution than ones with natural draught, but their useful effect is not significantly better.

THE EFFICIENCY OF THE BOILER

How good a boiler is partially depends on the proportion of the energy in the fuel that it transfers to the central heating system. This proportion is called the “efficiency”. The efficiency of a boiler is defined as the relationship between the energy in the hot water and that in the wood: the higher the efficiency, the more of the energy in the fuel is transferred to the water in the boiler. Good boilers have a efficiency of the order of 80-90%.

The a wood consumption in reverse burning boiler is typically between 4 kg/hour for 18 kW boiler to 18 kg/hr for 80 kW boiler. In Central European condition an average single family house (150 m2) need cca 12 m3 of wood for the whole heating season. Typical boilers can burn wood logs up

to 80 cm long. More technical data for Central European condition see the table bellow.

Power output (kW)	Wood consumption (kg/hr)	Wood consumption in heating season (m3)
18	4	10
25	6	15
32	7	20
50	13	30
80	18	50

Wood heating value 15-18 MJ/kg.

STORAGE TANK

It almost always pays to buy a storage tank when installing a wood burning boiler. A storage tank holds water that has been heated up by the boiler. The extra cost repays itself very quickly, and it is easier to fire properly. Shortly after lighting up, combustion is clean and the boiler starts producing masses of heat. Without a storage tank to take up the heat, the water will rapidly get too hot and the damper will have to be shut to stop it boiling. The reduced amount of air leads to smoky, incomplete combustion.

But with a hot water tank you can fire away and store the heat. The water in the boiler cannot overheat because it goes into the tank. The damper remains open and combustion continues at high efficiency. When you need heat in the radiators, it comes from the storage tank. The size of the storage tank depends on the amount of heat the house needs and the efficiency of the boiler.

BURNING WOOD COMBINED WITH SOLAR HEATING

If you do decide to install a wood burning unit, it is recommended also to consider putting in solar heating. The wood burning boiler and the solar panels can frequently use the same storage tank, reducing the cost of the system as a whole. Make sure first that the storage tank is suitable for the purpose. At the same time it makes it unnecessary to have a fire going in summer just to get hot water. And it is cheaper to “burn” solar energy than wood!

FUEL CHOICE

Whatever fuel you decide to use, it must be dry. Newly felled timber has a water content of about 50%, which makes it uneconomical to burn. This is because a proportion of the energy in the wood goes to evaporating the water off, giving less energy for heat. So wood has to be dried before it can be burnt. The best thing to do is to leave the wood to dry for at least a year, and preferably two. It is easiest to stack it in an outdoor woodshed so that the rain cannot get at it.

Never burn wood that has been painted or glued, since toxic gases are formed on combustion. Nor should one burn refuse such as waxed paper milk cartons and that sort of thing. You can also burn wood briquettes. They are made of compressed sawdust and wood shavings, about 10 or 20 cm long and 5 cm in diameter. Because they are compressed and have a low water content they have a higher energy density than ordinary wood, so they need less storage space.

CHIMNEY

Chimney is responsible for the draught going through the boiler. The difference in the density of the air between the top of the chimney and the outlet on the boiler is what creates the draught. So the height of the chimney, the insulation, and thus the temperature of the smoke all contribute to

the draught. Bends and horizontal bits of piping reduce the draught. They create resistance, which the hot air has to overcome. So the idea is to have as few horizontal flues and bends as possible. Some boilers have a built-in blower, ensuring a proper draught at all times.

BOILER MAINTENANCE

A boiler must be installed and maintained properly. This increases its life and your safety. Most countries have regulations about siting: in some places boilers have to be put in a separate room. The chimney will need sweeping at least once a year. This reduces the risk of fire. Too much soot may mean you are not letting enough air through.

3.8.3 WOOD PELLETS AND WOOD CHIPS IN AUTOMATICALLY-FIRED BOILERS

The automatic boiler is connected to the central heating system in exactly the same way as an oil-fired one. The heat of combustion is transferred to water, which is heated up and carried round the house to the radiators. The automatic boiler thus supplies heat to all the radiators in the house, unlike a wood burning stove, which really only heats the room it is in. Pellets and wood-chips are of a size and shape that make them ideal for automatic boilers, since they can be fed in directly from a bunker. This makes it much easier to stoke, since the bunker only needs filling up once or twice a week. In hand-fired units like wood burning boilers, one has to stoke up several times a day - though they are usually cheaper to buy than automatic ones.

WOOD PELLETS

Wood pellets are a comparatively new and attractive form of fuel. When you burn wood pellets, you are utilising an energy resource that would otherwise have gone to waste or been dumped in a landfill. Pellets are usually made out of waste (sawdust and wood shavings), and are used in large quantities by district heating systems. The pellets are made in presses, and come out 1-3 cm long and about 1 cm wide. They are clean, pleasant smelling and smooth to touch. Wood pellets have a low moisture content (under 10% by weight), giving them a higher combustion value than other wood fuels. The fact that they are pressed means they take up less space, so they have a higher volume energy (more energy per cubic meter). The burning process is highly combustible and produces little residue. Some countries have exempted pellet appliances from the smoke emission testing requirements.

There are different kinds of pellets. Some manufacturers use a bonding agent to extend the life of the pellets; others make them without it. The bonder used often contains sulphur, which goes up the chimney on burning. Sulphate pollution contributes to acid rain and chimney corrosion, so it is best to buy pellets without a bonding agent.

Wood pellets characteristics:
Diameter : 5 - 8 mm
Length : max. 30 mm
Density : min. 650 kg/m3
Moisture content : max. 8% of weight
Energy value : 4,5 - 5,2 kWh/kg
2 kg pellets = 1 litre of heating oil

There are many advantages in using pellets as the fuel of choice. No trees are cut to make the pellets - they are only made from leftover wood residue. Burning pellet fuel actually helps reduce waste created by lumber production or furniture manufacturing. There are no additives put into the pellets to make them burn longer or more efficiently. Pellet fuel does not smoke or give off any

harmful fumes. Using this fuel reduces the need for fossil fuels which are known to be harmful for the environment.
The cost of pellet fuel may depend on the geographic region where it is sold, and the current season. Whether you live in a condominium in the city or a home in the country, pellet fuel is among the safest, healthiest way to heat. This technology is also valuable for non-residential buildings such as hotels, resorts, restaurants, retail stores, offices, hospitals, and schools. Pellets are recently used in over 500 000 homes in North America.

WOOD-CHIPS
Wood-chips are made of waste wood from the forests. Trees have to be thinned to make room for commercial timber (beams, flooring, furniture). Wood-chips are thus a waste product of normal forestry operations. Wood is cut up in mechanical chippers. The size and shape of the chips depends on the machine, but they are typically about a centimetre thick and 2 to 5 cm long. The water content of newly felled chips is usually about 50% by weight, but this drops considerably on drying. In many countries like in Denmark wood-chips currently produced are burnt in wood-chip fired district heating stations. They are usually delivered by road, so there must be facilities for storing at least 20 m3 of chips under cover if they are to be used in an automatic burner.

FUEL CONSUMPTION AND INVESTMENT COST
In the table bellow you can find a comparison of different wood burning systems for single family house 150 m2 (12 kW heat load). Data are coming from Austria.

Fuel	Investment costs	Fuel consumption in heating season	Operation
Logs	From 80 000 ATS	12 m3	Fuel input 1-2 times a day
Wood chips	From 150 000 ATS	28 m3	Fuel input 1-2 times a year
Wood Pellets	From 80 000 ATS	7,5 m3	Automatic

Note 14 ATS = 1 USD

BOILER TYPES FOR WOOD PELLETS AND WOOD CHIPS
Automatic furnaces come in three types :
* Compact units in which the boiler and bunker are in one.
* Stoker-fired units, with separate boiler and bunker.
* Boilers with built-in pre-furnace.

COMPACT UNITS
In compact units the fuel is fed into the fire from the bunker by an automatic feeder. The rate at which fuel is fed in is determined by a thermostat, which puts less in when the water is hot and more in when it is cold. Compact units are excellent for wood pellets, but not for wood-chips. This is due to the lower volume energy of chips, so that stoking has to be more frequent. In addition, the water content of wood-chips is often so high that compact units do not combust them properly.

STOKER-FIRED UNITS
In stoker-fired units too, the fuel is automatically fed into the boiler. This is a helical conveyor which conveys the fuel from the bunker to the boiler. The fuel is fed in at the bottom of the grate, where it burns. As in compact units, feed-in is thermostatically controlled. Wood pellets are best

for stoker-fired units, but chips can also be used if the unit is designed for them. The chips must not be too moist, so they need drying first. The best way of doing this is to leave the trees outside to dry until they are put through the chipper. Chips can also be dried under cover after being cut up. If wood-chips are used, they need drying under cover for at least two months. They also need a lot of storage space.

BOILERS WITH PRE-FURNACE

In the third type of unit most of the combustion takes place at high temperature in a pre-furnace. The pre-furnace is earthenware-lined, allowing high temperatures to be maintained. A pre-furnace-mounted boiler is therefore highly suitable for burning wet wood-chips. Heat comes in from the pre-furnace and is transferred to the water in the boiler. Any gases not combusted in the pre-furnace are burnt off in the boiler. Boilers fitted with pre-furnace are designed for burning wood-chips. Some can also burn pellets, though others would be damaged by the heat generated by the dry fuel. Ask the manufacturer before buying.

COSTS

It costs more to buy an automatic stoker unit than a hand-fired one, because there are more bits and pieces in it. Usually they can be economical if there is a need for a lot of heat during the year. In EU countries it means to have a need to burn the equivalent of at least 3,000 litres of oil a year. If the homeowner use less, it is better to buy a hand-fired unit burning firewood. If the house is already equipped with a boiler that works well and the homeowner is thinking of buying an automatic unit, the cheapest thing is to invest in a separate stoker. In Denmark this sort of thing costs about DKK 20-25,000 to install. A compact unit, a stoked unit or a pre-furnace boiler cost at least DKK 50,000. Despite this a wood burning unit pays in the long run, because the saving on fuel is of the order of DKK 2,000 for each 1,000 litres of oil replaced.

MAINTENANCE

Maintenance is very important, otherwise there is a risk of chimney fires and carbon monoxide poisoning. A properly maintained fire utilises fuel better and gives better value for money. The working life of the unit also depends on maintenance.

3.8.4 STRAW FIRING BOILERS

Straw has a heating value which is similar to that of wood and can be used as a fuel in boilers. Nevertheless there are some difficulties which make straw a fuel source utilised only in large boilers usually connected to district heating systems and agriculture sector .

Straw is a difficult type of fuel. It is difficult to handle and to feed into a boiler because it is inhomogeneous, relatively moist, and bulky in proportion to its energy content: its volume is approx. 10-20 times that of coal. Moreover 70% of the combustible part of the straw is contained in the gases emitted during heating, the so called volatile components. Such a high content of volatile gases makes special demands on the distribution and mixing of the combustion air and to the design of the burner and the combustion chamber. Straw also contains many chlorine compounds which may cause corrosion problems, particularly with high surface temperatures. The softening and melting temperatures of straw ash are relatively low due to a large content of alkali metals. As a consequence, slugging problems may occur at low surface temperatures.

3.8.4.1 District heating systems

Despite all problems with the straw there is a huge number of straw-fired district heating plants all

around the world. Only in Since 1980 more than 70 such plants have been built in Denmark alone. Their output power range from 0,6 MW to 9 MW and the average size is 3,7 MW. These plants use mostly so called Hesston bales of straw with the dimensions 2,4x1,2x1,3 m and a weight of 450 kg. It is common to have a back up system based on oil or gas-fired boiler which can cover required output during peak load situations, repairs and breakdowns. Thus the straw-fired boiler is usually dimensioned for 60-70 % of maximum load which makes it easier to operate at low summer load level.
Straw-firing plants are made up of the same main components :
* Straw storage building
* Straw weighing device
* Straw crane
* Conveyor (feeding unit)
* Feeding system
* Boiler
* Flue gas cleaning
* Stack

BOILER
The conveyor carries the straw into the bottom of the boiler which consists of a sturdy iron grate. This is the place where the combustion takes place. The grate is usually divided into several combustion zones with separate blowers supplying combustion air through the grate. Combustion can be controlled individually in each zone , thus an acceptable burn-out of the straw can be obtained. Most of the energy content of the straw is represented by volatile gases (approx. 70%) which are released during heating and are burned off in the combustion chamber above the grate. In order to provide combustion air for the gases, secondary air is supplied through nozzles located in the boiler walls. From the combustion chamber, the flue gases are led to the convection section of the boiler where most of the heat is transferred through the boiler wall to the circulating boiler water. The convector is usually made up of rows of vertical pipes through which the flue gases pass. Most existing plants have an economiser , i.e. a heat exchanger installed after the convector. In this unit , the flue gases transmit more heat to the boiler water, resulting in an increased efficiency of the system.

QUALITY REQUIREMENTS TO THE STRAW
The straw supplied to the plants must conform to certain requirements in order to reduce the risk of operating problems during various processes of energy production. Storage, handling, dosing, feeding, combustion, and the environmental consequences of those processes are all potential causes of problems. The moisture content of the straw is the most important quality criteria for the this fuel. Moisture content varies between 10-25% but in some cases it may be even higher. The calorific value (energy content per kg) of the straw is directly proportional to the moisture content from which the price is calculated.
All heating plants specify a maximum acceptable moisture content in straw supplied. A high water content may cause storing problems and plant malfunction as well as reduced capacity and increased generating costs during handling, dosing and feeding (and possibly a reduction in boiler efficiency). The maximum acceptable moisture content varies from plant to plant but it is usually 18-22% water. Different types of straw behave very differently during combustion. Some types burn almost explosively, leaving hardly any ash, whereas other types burn very slowly, leaving

almost complete skeletons of ash on the grate. Experience from straw-fired district heating plants is not always identical from plant to plant, and the different combustion conditions can rarely be explained on the basis of ordinary laboratory examinations.

3.8.4.2 Heating plants smaller than 1 MW

This type of plant differs technically from district heating plants and is used mostly in agriculture. The use of straw for energy production in the agricultural sector as we know it today started in the 1970's as a result of the "energy crisis" and the resulting subsidies for the installation of straw-fired boilers. During the past 10-15 years, the concept of burning straw has developed from small primitive and labour-demanding boilers with batch firing and considerable smoke problems into large boilers emitting little smoke which are either batch-fired or automatic with fuel being supplied only 1-2 times per day.

BATCH-FIRED BOILERS

Earlier, the market was dominated by boilers for small bales. Today, however, most of the batch-fired boilers are designed for big bales (round bales, medium-sized bales or Hesston bales).The big bale boilers are well suited for an annual heating requirement corresponding to at least 10,000 litres of oil. The boilers are available in different sizes, holding from 1 round bale (200-300 kg) to 2 Hesston bales (1,000 kg). The boiler is fired with 1 bale at a time. A tractor fitted with a grab or a fork introduces the bale through a feeding gate at the front of the boiler. In order to ensure proper combustion and minimize particle emission from flue gases, air velocity and supply may be regulated through gradually changing between the upper and lower section of the boiler and by adjusting the air volume.

Batch-fired boilers used to cause many problems when fed with straw of inferior quality and the supply of combustion air was difficult to control. In recent models, however, the control problem has eventually been solved but the water content of the straw must still be kept below 15- l8 %. Today, an efficiency of 75% and a CO content below 0.5% is possible in batch-fired boilers. About l0 years ago, the efficiency was only 35%.

AUTOMATICALLY FIRED BOILERS

Interest in automatically fired boilers is due to the large amount of labour needed when operating small bale boilers with batch firing which used to be very popular. Several types of automatic boiler plants have been developed but they all include a dosing device which automatically feeds the straw into the boiler continuously. The dosing device may be designed for whole bales, cut straw or straw pellets.

BOILERS FOR BALES OF STRAW

Units consisting of a scarifier/cutter have been developed which separate the bales, parting them into pieces of varying sizes. The bales are fed into this unit on a conveyor. The volume of straw treated is often regulated by merely modifying the velocity of the conveyor. The straw is transported from the scarifier/cutter by worm conveyors or blowers. If blowers are used, the distance to the boiler can be greater than with worms but this equipment also consumes more energy.

The scarifier does not actually cut or shred the straw but it separates the straw into the segments it was compacted into by the piston of the baler. In order to ensure a steady flow of straw through the transport system, the scarifier usually has a retaining device. Most scarifiers have knives to loosen the straw without creating large lumps.

In automatically fired boilers, combustion takes places as the straw is fed into the boiler. The air supply is adapted to the straw volume by means of an adjustable damper on a blower. This ensures a good combustion, a significantly improved utilization factor, and a corresponding reduction of particle emission problems as compared with the first manually fired boilers without air regulating devices. Straw ignites easily in an automatic boiler because fresh straw is supplied continuously.

BOLLERS FOR PELLETS

The use of straw pellets for energy production has aroused some interest in recent years.
Until now, only small quantities of straw pellets have been produced. Of interest is the homogeneous and handy nature of this fuel which makes it perfect for transport in tankers and for use in automatic heating plants.
There are, however, still unsolved slag problems when the pellets are used in small boilers. The possibility of establishing a sales network for rural districts and villages is being considered in some developed countries.
Pellet-fed plants are usually intended for domestic heating and they consist of a boiler and a closed magazine for fuel (straw pellets). A stoker worm feeds the fuel into a hearth located in the boiler. When the plant is operating, the stoker worm works intermittently and the feeding capacity is regulated by adjusting its on/off intervals. Combustion air is supplied by a blower. The amount of ash from a small straw-fired boiler is typically 4% by weight of the straw used.

3.8.5 EFFICIENT WOOD BURNING TECHNIQUES FOR DEVELOPING COUNTRIES

For more than a third of the world's people, the real energy crisis is a daily scramble to find the wood they need to cook dinner. Their search for wood, once a simple task, has changed as forests recede, to a day's labour in some places. Reforestation, use of alternative fuels and fuel conservation through improved stoves are the three methods which offer possible solutions to the firewood crisis. Reforestation programs have been started in many countries, but the high rate of growth in demand means that forests are being cut much faster than they are being replanted. Alternative fuels like biogas and solar energy can be one part of solution. Another part consists of utilisation of efficient wood burning techniques like improved cook stoves.

3.8.5.1 Fuel-efficient cook stoves

The most immediate way to decrease the use of wood as cooking fuel is to introduce improved wood- and charcoal-burning cook stoves. Simple stove models already in use can halve the use of firewood. A concerted effort to develop more efficient models might reduce this figure to 1/3 or ¼, saving more forests than all of the replanting efforts planned for the rest of the century. Using simple hearths such as those used in India, Indonesia, Guatemala and elsewhere, one-third as much wood would provide the same service. These clay "cookers" are usually built on the spot with a closed hearth, holes in which to place the vessels to be heated, and a short chimney for the draught. Their energy yield varies, depending on the model, between approximately 15 and 25%. If these "cookers" were used throughout the Sahel, firewood consumption would be reduced by two-thirds: 0,2 m3 instead of 0,6 m3 per person per year. There are clear benefits of improved cook stoves to the individual family, the local community, the nation and the global community. In brief, they include:
* Less time spent gathering wood or less money spent on fuel,- less smoke in the kitchen; lessening of respiratory problems associated with smoke inhalation,- less manure used as fuel, releasing more fertilizer for agriculture,- little initial cost compared to most other kinds of cookers,

- improved hygiene with models that raise cooking off the floor, - safety: fewer burns from open flames; less chance of children falling into the fire or boiling pots; if pots are securely set into the stove, less chance of children pulling them down on themselves,- cooking convenience: stoves (an be made to any height and can have work space on the surface, - the fire requires less attention, as stoves with damper control can be easier to tend.
* Stove building may create new jobs,- potential for using local materials and- potential for local innovations,- money and time saved can be invested elsewhere in the community.
* Lowered rate of deforestation improves climate, wood supply and hydrology; decreases soil erosion,- potential for reducing dependence on imported fuel.

COOKING WITH RETAINED HEAT

In regions where much of the daily cooking involves a long simmering period (required for many beans, grains, stews and soups) the amount of fuel needed to complete the cooking process can be greatly reduced by cooking with retained heat. This is a practice of ancient origin which is still used in some parts of the world today.
In some areas a pit is dug and lined with rocks previously heated in a fire. The food to be cooked is placed in the lined pit, often covered with leaves, and the whole is covered by a mound of earth. The heat from the rocks is retained by the earth insulation, and the food cooks slowly over time. Another version of this method consists of digging a pit and lining it with hay or another good insulating material. A pot of food which has previously been heated up to a boil is placed in the pit, covered with more hay and then earth, and allowed to cook slowly with the retained heat.

THE HAYBOX COOKER

This latter method is the direct ancestor of the Haybox Cooker, which is simply a well insulated box lined with a reflective material into which a pot of food previously brought to a boil is placed. The food is cooked in 3 to 6 hours by the heat retained in the insulated box. The insulation greatly slows the loss of conductive heat, convective heat in the surrounding air is trapped inside the box, and the shiny lining reflects the radiant heat back into the pot.
Simple haybox style cookers could be introduced along with fuel-saving cook stoves in areas where slow cooking is practised. How these boxes should be made, and from what materials, is perhaps best left to people working in each region. Ideally, of course, they should be made of inexpensive, locally available materials and should fit standard pot sizes used in the area.

BUILDING INSTRUCTIONS

There are several principles which should be kept in mind in regard to the construction of a haybox cooker:
* Insulation should cover an six sides of the box (especially the bottom and lid). If one or more sides are not insulated, heat will be lost by conduction through the uninsulated sides and much efficiency will be lost.
* The box should be airtight. If it is not airtight, heat will be lost through warm air escaping by convection out of the box.
* The inner surfaces of the box should be of a heat reflective material (such as aluminium foil) to reflect radiant heat from the pot back to it.
A simple, lightweight haybox can be made from a 60 by 120 cm sheet of rigid foil-faced insulation and aluminium tape. Haybox cookers can also be constructed as a box-in-a-box with the intervening space filled with any good insulating material. The required thickness of the insulation will vary with how efficient it is (see below).

Good Insulating Materials	Suggested Wall Thickness
Cork	5 cm
Polystyrene sheets/pellets/drinking cups	5 cm
Hay/straw/rushes	10 cm
Sawdust/wood shavings	10 cm
Wool/fur	10 cm
Fiberglas/glass wool	10 cm
Shredded newspaper/cardboard	10 cm
Rice hulls/nut shells	15 cm

The inner box should have a reflective interior: aluminium foil, shiny aluminium sheeting, old printing plates, other polished sheet metal' or silver paint will all work. The box can be wooden, or a can-in-a-can, or cardboard, or any combination; a pair of cloth bags might also work. Be inventive. Always be sure the lid is air tight.

INSTRUCTIONS FOR USE

There are some adjustments involved in cooking with haybox cookers:

* Less water should be used since it is not boiled away.
* Less spicing is needed since the aroma is not boiled away.
* Cooking must be started earlier to give the food enough time to cook at a lower temperature than over a stove.
* Haybox cookers work best for large quantities (over 4 lifers) as small amounts of food have less thermal mass and cool faster than a larger quantity. Two or more smaller amounts of food may be placed in the box to cook simultaneously.
* The food should boil for several minutes before being placed in the box. This ensures that all the food is at boiling temperature, not just the water.

The boxes perform best at low altitudes where boiling temperature is highest. They should not be expected to perform as well at high altitudes. One great advantage of haybox cookers is that the cook no longer has to keep up a fire or watch or stir the pot once it's in the box. In fact, the box should not be opened during cooking as valuable heat is lost. And finally, food will never burn in a haybox.

SAND/CLAY STOVES: THE LORENA SYSTEM

The Lorena system involves building a solid sand/clay block, then carving out a firebox and flue tunnels. The block is an integral sand/clay mixture which, upon drying, has the strength of a weak concrete (without the cost). The mixture contains 2 to 5 parts of sand to 1 part of clay, though the proportions can differ widely.

Pure clay stoves crack badly because the clay shrinks as it dries and expands when it is heated. Sand/clay stoves are predominantly sand, with merely enough clay to glue the sand together. The mix should contain enough clay to bind the sand grains tightly together. The sand/clay mixture is strong in compression, but resists impact poorly. It is adequately strong in tension if thin walls are avoided. Unlike concrete, which works well as a thin shell, the sand/clay mixture relies upon mass for tensile strength.

Advantages:
* Sand and clay are available in most places, and cheap.
* The material is versatile; it can be used to build almost any size or shape of stove.
* The tools required are simple.
* Construction of the stoves requires simple skills.
* Stoves are easy to repair or replace.

Disadvantages:
* Construction relies on heavy materials that are not always available at the building site and are difficult to transport.
* The stoves are not transportable.
* Sand/clay stoves are not waterproof.
* Stove construction can require several days of hard work.
* Efficiency of the stoves relies on the quality of the workmanship in their construction. Normally, they can be expected to work well for at least a year, after which they may need to be repaired.

KENYA STOVE
One of the most successful urban stove projects in the world is the Kenya Ceramic Jiko (KCJ) initiative. Over 500,000 stoves of this new improved design have been produced and disseminated in Kenya since the mid-1980s (Davidson and Karekezi, 1991). Known as the Kenya Ceramic Jiko, KCJ for short, the improved stove is made of ceramic and metal components and is produced and marketed through the local informal sector. One of the key characteristics of this project was its ability to utilize the existing cook stove production and distribution system to produce and market the KCJ. Thus, the improved stove is fabricated and distributed by the same people who manufacture and sell the traditional stove design.
Another important feature of the Kenya stove project is that the KCJ design is not a radical departure from the traditional stove. The KCJ is, in essence, an incremental development from the traditional all-metal stove. It uses materials that are locally available and can be produced locally. In addition, the KCJ is well adapted to the cooking patterns of a large majority of Kenya's urban households. In many respects, the KCJ project provides an ideal case study of how an improved stove project should be initiated and implemented.

3.8.5.2 CHARCOAL PRODUCTION - PYROLYSIS
The production of charcoal spans a wide range of technologies from simple and rudimentary earth kilos to complex, large-capacity charcoal retorts. The various production techniques produce charcoal of varying quality. Improved charcoal production technologies are largely aimed at attaining increases in the net volume of charcoal produced as well as at enhancing the quality characteristics of charcoal.
Typical characteristics of good-quality charcoal:
Ash content : 5 per cent
Fixed carbon content : 75 per cent
Volatiles content : 20 per cent
Bulk density : 250-300 kg/m3
Physical characteristics : Moderately friable

Efforts to improve charcoal production are largely aimed at optimising the above characteristics at

the lowest possible investment and labour cost while maintaining a high production volume and weight ratios with respect to the wood feedstock.
The production of charcoal consist of six major stages:
1. Preparation of wood
2. Drying - reduction of moisture content
3. Pre-carbonization - reduction of volatiles content
4. Carbonization - further reduction of volatiles content
5. End of carbonization - increasing the carbon content
6. Cooling and stabilization of charcoal

The first stage consists of collection and preparation of wood, the principal raw material. For small-scale and informal charcoal makers, charcoal production is an off-peak activity that is carried out intermittently to bring in extra cash. Consequently, for them, preparation of the wood for charcoal production consists of simply stacking odd branches and sticks either cleared from farms or collected from nearby woodlands. Little time is invested in the preparation of the wood. The stacking may, however, assist in drying the wood which reduces moisture content thus facilitating the carbonization process. More sophisticated charcoal production systems entail additional wood preparation, such as debarking the wood to reduce the ash content of the charcoal produced. It is estimated that wood which is not debarked produces charcoal with an ash content of almost 30 per cent. Debarking reduces the ash content to between 1 and 5 per cent which improves the combustion characteristics of the charcoal.
The second stage of charcoal production is carried out at temperatures ranging from 110 to 220 degrees Celsius. This stage consists mainly of reducing the water content by first removing the water stored in the wood pores then the water found in the cell walls of wood and finally chemically-bound water.
The third stage takes place at higher temperatures of about 170 to 300 degrees and is often called the pre-carbonization stage. In this stage pyroligneous liquids in the form of methanol and acetic acids are expelled and a small amount of carbon monoxide and carbon dioxide is emitted.
The fourth stage occurs at 200 to 300 degrees where a substantial proportion of the light tars and pyroligneous acids are produced. The end of this stage produces charcoal which is in essence the carbonized residue of wood.
The fifth stage takes place at temperatures between 300 degrees and a maximum of about 500 degrees. This stage drives off the remaining volatiles and increases the carbon content of the charcoal.
The sixth stage involves cooling of charcoal for at least 24 hours to enhance its stability and reduce the possibility of spontaneous combustion.
The final stage consists of removal of charcoal from the kiln, packing, transporting, bulk and retail sale to customers. The final stage is a vital component that affects the quality of the finally-delivered charcoal. Because of the fragility of charcoal, excessive handling and transporting over long distances can increase the amount of fines to about 40 per cent thus greatly reducing the value of the charcoal. Distribution in bags helps to limit the amount of fines produced in addition to providing a convenient measurable quantity for both retail and bulk sales.

3.8.6 Wood Gasification Basics

Wood gasification is also called producer gas generation and destructive distillation. The essence of the process is the production of flammable gas products from the heating of wood. Carbon

monoxide, methyl gas, methane, hydrogen, hydrocarbon gases, and other assorted components, in different proportions, can be obtained by heating or burning wood products in an isolated or oxygen poor environment. This is done by burning wood in a burner which restricts combustion air intake so that the complete burning of the fuel cannot occur. A related process is the heating of wood in a closed vessel using an outside heat source. Each process produces different products. If wood were given all the oxygen it needs to burn cleanly the by-products of the combustion would be carbon dioxide, water,
some small amount of ash, (to account for the inorganic components of wood) and heat. This is the type of burning we strive for in wood stoves. Once burning begins though it is possible to restrict the air to the fuel and still have the combustion process continue. Lack of sufficient oxygen caused by restricted combustion air will cause partial combustion. In full combustion of a hydrocarbon (wood is basically a hydrocarbon) oxygen will combine with the carbon in the ratio of two atoms to each carbon atom. It combines with the hydrogen in the ratio of two atoms of hydrogen to one of oxygen. This produces CO2 (carbon dioxide) and H2O (water). Restrict the air to combustion and the heat will still allow combustion to continue, but imperfectly. In this restricted combustion one atom of oxygen will combine with one atom of carbon, while the hydrogen will sometimes combine with oxygen and sometimes not combine with anything. This produces carbon monoxide, (the same gas as car exhaust and for the same reason) water, and hydrogen gas. It will also produce a lot of other compounds and elements such as carbon which is smoke. Combustion of wood is a bootstrap process. The heat from combustion breaks down the chemical bonds between the complex hydrocarbons found in wood (or any other hydrocarbon fuel) while the combination of the resultant carbon and hydrogen with oxygen-combustion-produces the heat. Thus the process drives itself. If the air is restricted to combustion the process will still produce enough heat to break down the wood but the products of this inhibited combustion will be carbon monoxide and hydrogen, fuel gases which have the potential to continue the combustion reaction and release heat since they are not completely burned yet. (The other products of incomplete combustion, predominately carbon dioxide and water, are products of complete combustion and can be carried no further.) Thus it is a simple technological step to produce a gaseous fuel from solid wood. Where wood is bulky to handle, a fuel like wood gas (producer gas) is convenient and can be burned in various existing devices, not the least of which is the internal combustion engine. A properly designed burner combining wood and air is one relatively safe way of doing this. so this water is available to play a part in the destructive distillation process. Wood also contains many other chemicals from alkaloid poisons to minerals. These also become part of the process. As a general concept, destructive distillation of wood will produce methane gas, methyl gas, hydrogen, carbon dioxide, carbon monoxide, wood alcohol, carbon, water, and a lot of other things in small quantities. Methane gas might make up as much as 75% of such a mixture. Methane is a simple hydrocarbon gas which occurs in natural gas and can also be obtained from anaerobic bacterial decomposition as “bio-gas” or “swamp gas”. It has high heat value and is simple to handle. Methyl gas is very closely related to methyl alcohol (wood alcohol) and can be burned directly or converted into methyl alcohol (methanol), a high quality liquid fuel suitable for use in internal combustion engines with very small modification. It’s obvious that both of these routes to the production of wood gas, by incomplete combustion or by destructive distillation, will produce an easily handled fuel that can be used as a direct replacement for fossil fuel gases (natural gas or liquefied petroleum gases such as propane or butane). It can be handled by the same devices that regulate natural gas and it will work in burners or as a fuel for internal combustion engines with some very important cautions.

3.8.6.1 Producer Gas Generators

The simplest device is a tank shaped like an inverted cone (a funnel). A hole at the top which can be sealed allows the user to load sawdust into the tank. There is an outlet at the top to draw the wood gas off. At the bottom the point of the "funnel" is opened and this is where the burning takes place. Once loaded (the natural pack of the sawdust will keep it from falling out the bottom) the sawdust is lit from the bottom using a device such as a propane torch. The sawdust smoulders away. The combustion is maintained by a source of vacuum applied to the outlet at the top, such as a squirrel cage blower or an internal combustion engine. Smoke is drawn up through the porous sawdust, being partly filtered in the process, and exits the burner at the top where it goes on to be further conditioned and filtered. The vacuum also draws air in to support the fire. This burner is crude and uncontrollable, especially as combustion nears the top of the sawdust pile. This can happen rapidly since there is no control to assure that the sawdust burns evenly. "Leads" of fire can form in the sawdust reaching toward the top surface. Once the fire breaks through the top of the sawdust the vacuum applied to the burner will pull large amounts of air in supporting full combustion and leaning out the value of the producer gas as a fuel. This process depends on the poor porosity of the sawdust to control the combustion air so chunk wood cannot be used since its much greater porosity would allow too much air in and user would achieve full combustion at very high temperatures rather than the smouldering and the partial combustion needed. Such a burner is unsatisfactory for prolonged gas generation but it is cheap to build and it will work with a lot of fiddling. For prolonged trouble free operation of a wood gas generator the burner unit must have more complete control of the combustion air and the fuel feed. There are various ways to do this. For example, if the point of above mentioned original funnel shaped burner is completely enclosed then control over the air entering the burner can be achieved. This configuration will successfully burn much larger amount of wood.

3.8.7 FERMENTATION - Conversion of biomass into ethanol

Alcohol can be used as a liquid fuel in internal combustion engines either on their own or blended with petroleum. Therefore, they have the potential to change and/or enhance the supply and use of fuel (especially for transport) in many parts of the world. There are many widely-available raw materials from which alcohol can be made, using already improved and demonstrated existing technologies. Alcohol have favourable combustion characteristics, namely clean burning and high octane-rated performance. Internal combustion engines optimized for operation on alcohol fuels are 20 per cent more energy-efficient than when operated on gasoline, and an engine designed specifically to run on ethanol can be 30 per cent more efficient. Furthermore, there are numerous environmental advantages, particularly with regard to lead, CO2, SO2, particulates, hydrocarbons and CO emissions.

Ethanol as most important alcohol fuel can be produced by converting the starch content of biomass feedstocks (e.g. corn, potatoes, beets, sugarcane, wheat) into alcohol. The fermentation process is essentially the same process used to make alcoholic beverages. Here yeast and heat are used to break down complex sugars into more simple sugars, creating ethanol. There is a relatively new process to produce ethanol which utilizes the cellulosic portion of biomass feedstocks like trees, grasses and agricultural wastes. Cellulose is another form of carbohydrate and can be broken down into more simple sugars. This process is relatively new and is not yet commercially available, but potentially can use a much wider variety of abundant, inexpensive feedstocks. Currently, about 6 billion litres of ethanol are produced this way each year in the U.S. World-wide,

fermentation capacity for fuel ethanol has increased eightfold since 1977 to about 20 billion litres per year. Latin America, dominated by Brazil, is the world's largest production region of bioethanol. Countries such as Brazil and Argentina already produce large amounts, and there are many other countries such as Bolivia, Costa Rica, Honduras and Paraguay, among others, which are seriously considering the bioethanol option. Alcohol fuels have also been aggressively pursued in a number of African countries currently producing sugar - Kenya, Malawi, South Africa and Zimbabwe. Others with great potential include Mauritius, Swaziland and Zambia. Some countries have modernized sugar industry and have low production costs. Many of these countries are landlocked which means that it is not feasible to sell molasses as a by-product on the world market, while oil imports are also very expensive and subject to disruption. The major objectives of these programmes are: diversification of the sugarcane industry, displacement of energy imports and better resource use, and, indirectly, better environmental management. These conditions, combined with relatively low total demand for liquid transport fuels, make ethanol fuel attractive. Global interest in ethanol fuels has increased considerably over the last decade despite the fall in oil prices after 1981. In developing countries interest in alcohol fuels has been mainly due to low sugar prices in the international market, and also for strategic reasons. In the industrialized countries, a major reason is increasing environmental concern, and also the possibility of solving some wider socio-economic problems, such as agricultural land use and food surpluses. As the value of bioethanol is increasingly being recognized, more and more policies to support development and implementation of ethanol as a fuel are being introduced.

Since ethanol has different chemical properties than gasoline, it requires slightly different handling. For example, ethanol changes from a liquid to a gas (evaporates) less readily than gasoline. This means that in neat (100%) ethanol applications, cold starts can be a problem. However, this issue can be resolved through engine design and fuel formulation. Changes in engine design will also allow for greater efficiency. Although a litre of ethanol has about two-thirds of the energy content of a litre of gasoline, tuning the engine for ethanol can make up as much as half the difference. Furthermore, since ethanol is an organic product, should there be a spill, it will biodegrade more quickly and easily than gasoline.

Using ethanol even in low-level blends (e.g. E10 - which is 10% ethanol, 90% gasoline) can have environmental benefits. Tests show that E10 produces less carbon monoxide (CO), sulphur dioxide (SO2) and carbon dioxide (CO2) than reformulated gasoline (RFG). These blends have helped clean up carbon monoxide problems in cities like Denver and Phoenix. However E10 produces more volatile organic compounds (VOC), particulates (PM), and nitrogen oxide (NOx) emissions than RFG. Higher blends (E85, which is 15% gasoline), or even neat ethanol-E100 - burn with less of virtually all the pollutants mentioned above.

The production of ethanol by fermentation involves four major steps: (a) the growth, harvest and delivery of raw material to an alcohol plant; (b) the pre-treatment or conversion of the raw material to a substrate suitable for fermentation to ethanol; (c) fermentation of the substrate to alcohol, and purification by distillation; and (d) treatment of the fermentation residue to reduce pollution and to recover by-products. Fermentation technology and efficiency has improved rapidly in the past decade and is undergoing a series of technical innovations aimed at using new alternative materials and reducing costs. Technological advances will have, however, less of an impact overall on market growth than the availability and costs of feedstock and the cost-competing liquid fuel options.

The many and varied raw materials for bioethanol production can be conveniently classified into three types: (a) sugar from sugarcane, sugar beet and fruit, which may be converted to ethanol

directly; (b) starches from grain and root crops, which must first be hydrolysed to fermentable sugars by the action of enzymes; and (c) cellulose from wood, agricultural wastes etc., which must be converted to sugars using either acid or enzymatic hydrolysis. These new systems are, however, at the demonstration stage and are still considered uneconomic. Of major interest are sugarcane, maize, wood, cassava and sorghum and to a lesser extent grains and Jerusalem artichoke. Ethanol is also produced from lactose from waste whey; for example in Ireland to produce potable alcohol and also in New Zealand to produce fuel ethanol. A problem still to be overcome is seasonability of crops, which means that quite often an alternative source must be found to keep a plant operating all-year round.

Sugarcane is the world's largest source of fermentation ethanol. It is one of the most photosynthetic efficient plants - about 2,5 % photosynthetic efficiency on an annual basis under optimum agricultural conditions. A further advantage is that bagasse, a by-product of sugarcane production, can be used as a convenient on-site electricity source. The tops and leaves of the cane plant can also be used for electricity production. An efficient ethanol distillery using sugarcane by-products can therefore be self-sufficient and also generate a surplus of electricity. The production of ethanol by enzymatic or acid hydrolysis of bagasse could allow off-season production of ethanol with very little new equipment.

METHANOL

Methanol is another alcohol fuel which can be obtained from biomass and coal. But methanol is currently produced mostly from natural gas and has only been used as fuel for fleet demonstration and racing purposes and, thus, will not be considered here. In addition, there is a growing consensus that methanol does not have all the environmental benefits that are commonly sought for oxygenates and which can be fulfilled by ethanol.

3.8.7.1 Brazil

Brazil first used ethanol as a transport fuel in 1903, and now has the world's largest bioethanol programme. Since the creation of the National Alcohol Programme (ProAlcool) in 1975, Brazil has produced over 90 billion litres of ethanol from sugarcane. The installed capacity in 1988 was over 16 billion litres distributed over 661 projects. In 1989, over 12 billion litres of ethanol replaced about 200,000 barrels of imported oil a day and almost 5 million automobiles now run on pure bioethanol and a further 9 million run on a 20 to 22 per cent blend of alcohol and gasoline (the production of cars powered by pure gasoline was stopped in 1979). From 1976 to 1987 the total investment in ProAlcool reached $6,970,000 million and the total savings equivalent in imported gasoline was $12,480,000 million.

Apart from ProAlcool's main objective of reducing oil imports, other broad objectives of the programme were to protect the sugarcane plantation industry, to increase the utilization of domestic renewable-energy resources, to develop the alcohol capital goods sector and process technology for the production and utilization of industrial alcohols, and to achieve greater socio-economic and regional equality through the expansion of cultivable lands for alcohol production and the generation of employment. Although ProAlcool was planned centrally, alcohol is produced entirely by the private sector in a decentralized manner.

The ProAlcool programme has accelerated the pace of technological development and reduced costs within agriculture and other industries. Brazil has developed a modem and efficient agribusiness capable of competing with any of its counterparts abroad. The alcohol industry is now among Brazil's largest industrial sectors, and Brazilian firms export alcohol technology to many

countries. Another industry which has expanded greatly due to the creation of ProAlcool is the ethanol chemistry sector.
Ethanol-based chemical plants are more suitable for many developing countries than petrochemical plants because they are smaller in scale, require less investment, can be set up in agricultural areas, and use raw materials which can be produced locally.

SOCIAL DEVELOPMENT
Rural job creation has been credited as a major benefit of ProAlcool because alcohol production in Brazil is highly labour-intensive. Some 700,000 direct jobs with perhaps three to four times this number of indirect jobs have been created. The investment to generate one job in the ethanol industry varies between $12,000 and $22,000, about 20 times less than in the chemical industry for example.

ENVIRONMENTAL IMPACTS
Environmental pollution by the ProAlcool programme has been a cause of serious concern, particularly in the early days. The environmental impact of alcohol production can be considerable because large amounts of stillage are produced and often escape into waterways. For each litre of ethanol produced the distilleries produce 10 to 14 litres of effluent with high biochemical oxygen demand (BOD) stillage. In the later stages of the programme serious efforts were made to overcome these environmental problems, and today a number of alternative technological solutions are available or are being developed, e.g., decreasing effluent volume and turning stillage into fertilizer, animal feed, biogas etc. These have sharply reduced the level of pollution and in Sao Paulo. The use of stillage as a fertilizer in sugarcane fields has increased productivity by 20-30 per cent.

ECONOMICS
Despite many studies carried out on nearly all aspects of the programme, there is still considerable disagreement with regard to the economics of ethanol production in Brazil. This is because the production cost of ethanol and its economic value to the consumer and to the country depend on many tangible and intangible factors making the costs very site-specific and variable even from day to day. For example, production costs depend on the location, design and management of the installation, and on whether the facility is an autonomous distillery in a cane plantation dedicated to alcohol production, or a distillery annexed to a plantation primarily engaged in production of sugar for export. The economic value of ethanol produced, on the other hand, depends primarily on the world prices of crude oil and sugar, and also on whether the ethanol is used in anhydrous form for blending with gasoline, or used in hydrous forte in 100 per cent alcohol-powered cars.
The costs of ethanol were declining at an annual rate of 4 per cent between 1979 and 1988 due to major efforts to improve the productivity and economics of sugarcane agriculture and ethanol production. The costs of ethanol production could be further reduced if sugarcane residues, mainly bagasse, were to be fully utilized. With sale credits from the residues, it would be possible to produce hydrous ethanol at a net cost of less than $0.15/litre, making it competitive with gasoline even at the low early-1990 oil prices. Using the biomass gasifier/intercooled steam-injected gas turbine (BIG/STIG) systems for electricity generation from bagasse, they calculated that simultaneously with producing cost-competitive ethanol, the electricity cost would be less than $0.0451kWh. If the milling season is shortened to 133 days to make greater use of the barbojo (tops and leaves) the economics become even more favourable. Such developments could have

significant implications for the overall economics of ethanol production.
Despite all the problems ProAlcool is an outstanding technical success that has achieved many of its aims, its physical targets were achieved on time and its costs were below initial estimates. It has enabled the sugar and alcohol industries to develop their own technological expertise along with greatly increased capacity. It has increased independence, made significant foreign-exchange savings, provided the basis for technological developments in both production and end-use, and created jobs. Overall, Brazil's success with implementing large-scale ethanol production and utilization has been due to a combination of factors which include: government support and clear policy for ethanol production; economic and financial incentives; direct involvement of the private sector; technological capability of the ethanol production sector; long historical experience with production and use of ethanol; co-operation between Government, sugarcane producers and the automobile industry; an adequate labour force; a plentiful, low-priced sugarcane crop with a suitable climate and abundant agricultural land; and a well established and developed sugarcane industry which resulted in low investment costs in seeing up new distilleries. In the specific case of ethanol-fuelled vehicles, the following factors were influential: government incentives (e.g., lower taxes and cheaper credit); security of supply and nationalistic motivation; and consistent price policy which favoured the alcohol-powered car.

3.8.7.2 Zimbabwe

Zimbabwe is an example of a relatively small country which has begun to tackle its import problem while fostering its own agro-industrial base. An independent and secure source of liquid fuel was seen as a sensible strategy because of Zimbabwe's geographical position, its politically vulnerable situation and foreign-exchange limitations, and for other economic considerations. Zimbabwe has no oil resources and all petroleum products must be imported, accounting for nearly $120 million per annum on average in recent years which amounted to 18 per cent of the country's foreign-exchange earnings. Since1980 Zimbabwe pioneered the production of fuel ethanol for blending with gasoline in Africa. Initially a 15-per cent alcohol/gasoline mix was used, but due to increased consumption, the blend is now about 12 per cent alcohol. This is the only fuel available in Zimbabwe for vehicles powered by spark-ignition engines. Annually, production of 40 million litres has been possible since 1983.

3.9 Low Cost Practical Designs of Biogas Technology

DECOMPOSITION

There are two basic type of decomposition or fermentation: natural and artificial aerobic decomposition. Anaerobic means in the absence of Air (Oxygen). Therefore any decomposition or fermentation of organic material takes place in the absence of air (oxygen) is known as anaerobic decomposition or fermentation. Anaerobic decomposition can also be achieved in two ways namely, (i) natural and (ii) artificial.

3.9.1 Digestible Property of Organic Matter

When organic raw materials are digested in an airtight container only a certain percentage of the waste is actually converted into Biogas and Digested Manure. Some of it is indigestible to varying degree and either gets accumulated inside the digester or discharged with the effluent. The digestibility and other related properties of the organic matter are usually expressed in the following terms:

Moisture
This is the weight of water lost upon drying of organic matter (OM) at 100 degrees Celsius (0,10 degrees Celsius (220 deg.F). This is achieved by drying the organic matter for 48 hours in an oven until no moisture is lost. The moisture content is determined by subtracting the final (dried) weight from the original weight of the OM, taken just before putting in the oven.

Total Solids (TS)
The weight of dry matter (DM) or total solids (TS) remaining after drying the organic matter in an oven as described above. The TS is the "Dry Weight" of the OM (Note: after the sun drying the weight of OM still contains about 20% moisture). A figure of 10% TS means that 100 gm of sample will contain 10 gm of moisture and 90 gm of dry weight. The Total Solids (TS) consists of Digestible Organic (or Volatile Solids-VS) and the indigestible solid (Ash).

Volatile Solids (VS)/ Volatile Matter (VM)
The weight of burned-off organic matter (OM) when "Dry Matter-DM" or "Total Solids-TS" is heated at a temperature of 550 degrees Celsius(0,50 degrees Celsius or 1000 deg. F) for about 3 hours is known as Volatile Solids (VS) or Volatile Matter (VM). Muffle Furnace is used for heating the Dry Matter or Total Solids of the OM at this high temperature after which only ash (inorganic matter) remains. In other wards the Volatile Solids (VS) is that portion of the Total Solids (TS) which volatilizes when it is heated at 550 degrees Celsius and the inorganic material left after heating of OM at this temperature is know as Fixed Solids or Ash. It is the Volatile Solids (VS) fraction of the Total Solids (TS) which is converted by bacteria (microbes) in to biogas.

Fixed Solids (FS) or Ash
The weight of matter remaining after the sample is heated at 550 degrees Celsius is known as Fixed Solids (FS) or ash. The Fixed Solids is biologically inert material and is also known as Ash.

3.9.2 Biogas Production System
The biogas (mainly mixture of methane and carbon dioxide) is produced/generated under both, natural and artificial conditions. However for techno-economically-viable production of biogas for wider application the artificial system is the best and most convenient method. The production of biogas is a biological process which takes place in the absence of air (oxygen), through which the organic material is converted in to, essentially Methane (CH_4) and Carbon dioxide (CO_2) and in the process gives excellent organic fertilizer and humus as the second by-product. The one essential requirement in producing biogas is an airtight (air leak-proof) container. Biogas is generated only when the decomposition of biomass takes place under the anaerobic conditions, as the anaerobic bacteria (microbes) that live without oxygen are responsible for the production of this gas through the destruction of organic matter. The airtight container used for the biogas production under artificial condition is known as digester or reactor.

3.9.3 Composition of Biogas
Biogas is a colourless, odourless, inflammable gas, produced by organic waste and biomass decomposition (fermentation). Biogas can be produced from animal, human and plant (crop) wastes, weeds, grasses, vines, leaves, aquatic plants and crop residues etc. The composition of different gases in biogas :
Methane (CH_4) : 55-70%
Carbon Dioxide (CO_2) : 30-45%

Hydrogen Sulphide (H2S) : 1-2%
Nitrogen (N2) : 0-1%
Hydrogen (H2) : 0-1%
Carbon Mono Oxide (CO) : Traces
Oxygen (O2) : Traces

3.9.4 Property of Biogas

Biogas burns with a blue flame. It has a heat value of 500-700 BTU/Ft3 (4,500-5,000 Kcal/M3) when its methane content is in the range of 60-70%. The value is directly proportional to the amount of methane contains and this depends upon the nature of raw materials used in the digestion. Since the composition of this gas is different, the burners designed for coal gas, butane or LPG when used, as 'biogas burner' will give much lower efficiency. Therefore specially designed biogas burners are used which give a thermal efficiency of 55-65%.

Biogas is a very stable gas, which is a non-toxic, colourless, tasteless and odourless gas. However, as biogas has a small percentage of Hydrogen Sulphide, the mixture may very slightly smell of rotten egg, which is not often noticeable especially when being burned. When the mixture of methane and air (oxygen) burn a blue flame is emitted, producing large amount of heat energy. Because of the mixture of Carbon Dioxide in large quantity the biogas becomes a safe fuel in rural homes as will prevent explosion.

A 1 M3 biogas will generate 4,500-5,500 Kcal/m2 of heat energy, and when burned in specifically designed burners having 60% efficiency, will give out effective heat of 2,700-3,200 Kcal/m2. 1 Kcal is defined as the heat required to raise the temperature of 1 kg (litre) of water by 1 degrees Celsius. Therefore this effective heat (say 3,000 Kcal/m2 is on an average), is sufficient to bring approx. 100 kg (litre) of water from 20 degrees Celsius to a boil, or light a lamp with a brightness equivalent to 60-100 Watts for 4-5 hours.

3.9.5 Mechanics of Extraction of Biogas

The decomposition (fermentation) process for the formation of methane from organic material (biodegradable material) involves a group of organisms belonging to the family- 'Methane Bacteria' and is a complex biological and chemical process. For the understanding of common people and field workers, broadly speaking the biogas production involves two major processes consisting of acid formation (liquefaction) and gas formation (gasification). However scientifically speaking these two broad process can further be divide, which gives four stages of anaerobic fermentation inside the digester-they are (i) Hydrolysis, (ii) Acidification, (iii) Hydrogenation and (iv) Methane Formation. At the same time for all practical purposes one can take the methane production cycle as a three stage activity- namely, (i) Hydrolysis, (ii) Acidification and (iii) Methane formation.

Two groups of bacteria work on the substrate (feedstock) inside the digester-they are (i) Non-methanogens and (ii) Methanogens. Under normal conditions, the non-methanogenic bacteria (microbes) can grow at a pH range of 5.0-8.5 and a temperature range of 25-42 deg. ;whereas, methanogenic bacteria can ideally grow at a pH range of 6.5-7.5 and a temperature range of 25-35 degrees Celsius. These methanogenic bacteria are known as 'Mesophillic Bacteria' and are found to be more flexible and useful incase of simple household digesters, as they can work under a broad range of temperature, as low as 15 degrees Celsius to as high as 40 degrees Celsius. However their efficiency goes down considerably if the slurry temperature goes below 20 degrees Celsius and almost stop functioning at a slurry temperature below 15 degrees Celsius. Due to this

Mesophillic Bacteria can work under all the three temperature zones of India, without having to provide either heating system in the digester or insulation in the plant, thus keeping the cost of family size biogas plants at an affordable level.
There are other two groups of anaerobic bacteria-they are (i) Pyscrophillic Bacteria and (ii) Thermophillic Bacteria. The group of Pyscrophillic Bacteria work at low temperature, in the range of 10-15 degrees Celsius but the work is still going on to find out the viability of these group of bacteria for field applications. The group of Thermophillic Bacteria work at a much higher temperature, in the range of 45-55 degrees Celsius and are very efficient, however they are more useful in high rate digestions (fermentation), especially where a large quantity of effluent is already being discharged at a higher temperature. As in both the cases the plant design needs to be sophisticated therefore these two groups of Bacteria (Pyscrophillic & Thermophillic) are not very useful in the case of simple Indian rural biogas plant.

3.9.6 Biogas Plant (BGP)

Biogas Plant (BGP) is an airtight container that facilitates fermentation of material under anaerobic condition. The other names given to this device are ‘Biogas Digester’, ‘Biogas Reactor’, ‘Methane Generator’ and ‘Methane Reactor’. The recycling and treatment of organic wastes (biodegradable material) through Anaerobic Digestion (Fermentation) Technology not only provides biogas as a clean and convenient fuel but also an excellent and enriched bio-manure. Thus the BGP also acts as a miniature Bio-fertilizer Factory hence some people prefer to refer it as ‘Biogas Fertilizer Plant’ or ‘Bio-manure Plant’. The fresh organic material (generally in a homogenous slurry form) is fed into the digester of the plant from one end, known as Inlet Pipe or Inlet Tank. The decomposition (fermentation) takes place inside the digester due to bacterial (microbial) action, which produces biogas and organic fertilizer (manure) rich in humus & other nutrients. There is a provision for storing biogas on the upper portion of the BGP. There are some BGP designs that have Floating Gasholder and others have Fixed Gas Storage Chamber. On the other end of the digester Outlet Pipe or Outlet Tank is provided for the automatic discharge of the liquid digested manure.

3.9.6.1 Components of Biogas Plant (BGP)

The major components of BGP are - (i) Digester, (ii) Gasholder or Gas Storage Chamber, (iii) Inlet, (iv) Outlet, (v) Mixing Tank and (vi) Gas Outlet Pipe.

DIGESTER

It is either an under ground Cylindrical-shaped or Ellipsoidal-shaped structure where the digestion (fermentation) of substrate takes place. The digester is also known as ‘Fermentation Tank or Chamber’. In a simple Rural Household BGP working under ambient temperature, the digester (fermentation chamber) is designed to hold slurry equivalent to of 55, 40 or 30 days of daily feeding. This is known as Hydraulic Retention Time (HRT) of BGP. The designed HRT of 55, 40 and 30 days is determined by the different temperature zones in the country- the states & regions falling under the different temperature zones are already defined for India. The digester can be constructed of brick masonry, cement concrete (CC) or reinforced cement concrete (RCC) or stone masonry or pre-fabricated cement concrete blocks (PFCCB) or Ferro-cement (ferroconcrete) or steel or rubber or bamboo reinforced cement mortar (BRCM). In the case of smaller capacity floating gasholder plants of 2 & 3 M3 no partition wall is provided inside the digester, whereas the BGPs of 4 M3 capacity and above have been provided partition wall in the middle. This is provided for preventing short-circuiting of slurry and promoting better efficiency. This means the

partition wall also divides the entire volume of the digester (fermentation chamber) into two halves. As against this no partition wall is provided inside the digester of a fixed dome design. The reason for this is that the diameter of the digesters in all the fixed dome models are comparatively much bigger than the floating drum BGPs, which takes care of the short-circuiting problems to a satisfactory level, without adding to additional cost of providing a partition wall.

GAS HOLDER OR GAS STORAGE CHAMBER

In the case of floating gas holder BGPs, the Gas holder is a drum like structure, fabricated either of mild steel sheets or ferro-cement (ferroconcrete) or high density plastic (HDP) or fibre glass reinforced plastic (FRP). It fits like a cap on the mouth of digester where it is submerged in the slurry and rests on the ledge, constructed inside the digester for this purpose. The drum collects gas, which is produced from the slurry inside the digester as it gets decomposed, and rises upwards, being lighter than air. To ensure that there is enough pressure on the stored gas so that it flows on its own to the point of utilisation through pipeline when the gate valve is open, the gas is stored inside the gas holder at a constant pressure of 8-10 cm of water column. This pressure is achieved by making the weight of biogas holder as 80-100 kg/cm2. In its up and down movement the drum is guided by a central guide pipe. The gas formed is otherwise sealed from all sides except at the bottom. The scum of the semidried mat formed on the surface of the slurry is broken (disturbed) by rotating the biogas holder, which has scum-breaking arrangement inside it. The gas storage capacity of a family size floating biogas holder BGP is kept as 50% of the rate capacity (daily gas production in 24 hours). This storage capacity comes to approximately 12 hours of biogas produced every day.

In the case of fixed dome designs the biogas holder is commonly known as gas storage chamber (GSC). The GSC is the integral and fixed part of the Main Unit of the Plant (MUP) in the case of fixed dome BGPs. Therefore the GSC of the fixed dome BGP is made of the same building material as that of the MUP. The gas storage capacity of a family size fixed dome BGP is kept as 33% of the rate capacity (daily gas production in 24 hours). This storage capacity comes to approximately 8 hours of biogas produced during the night when it is not in use.

INLET

In the case of floating biogas holder pipe the Inlet is made of cement concrete (CC) pipe. The Inlet Pipe reaches the bottom of the digester well on one side of the partition wall. The top end of this pipe is connected to the Mixing Tank.

In the case of the first approved fixed dome models (Janata Model) the inlet is like a chamber or tank-it is a bell mouth shaped brick masonry construction and its outer wall is sloppy. The top end of the outer wall of the inlet chamber has an opening connecting the mixing tank, whereas the bottom portion joins the inlet gate. The top (mouth) of the inlet chamber is kept covered with heavy slab. The Inlet of the other fixed dome models (Deenbandhu and Shramik Bandhu) has Asbestos Cement Concrete (ACC) pipes of appropriate diameters.

OUTLET

In the case of floating gas holder pipe the Outlet is made of cement concrete (CC) pipe standing at an angle, which reaches the bottom of the digester on the opposite side of the partition wall. In smaller plants (2 & 3 M3 capacity BGPs) which has no partition walls, the outlet is made of small (approx. 2 ft. length) cement concrete (CC) pipe inserted on top most portion of the digester, submerged in the slurry.

In the two fixed dome (Janata & Deenbandhu models) plants, the Outlet is made in the form of rectangular tank. However, in the case of Shramik Bandhu model the upper portion of the Outlet (known as Outlet Displacement Chamber) is made hemi-spherical in shape, designed to save in the material and labour cost. In all the three-fixed dome models (Janata, Deenbandhu & Shramik Bandhu models), the bottom end of the outlet tank is connected to the outlet gate. There is a small opening provided on the outer wall of the outlet chamber for the automatic discharge of the digested slurry outside the BGP, equal to approximately 80-90% of the daily feed. The top mouth of the outlet chamber is kept covered with heavy slab.

MIXING TANK

This is a cylindrical tank used for making homogenous slurry by mixing the manure from domestic farm animals with appropriate quantity of water. Thoroughly mixing of slurry before releasing it inside the digester, through the inlet, helps in increasing the efficiency of digestion. Normally a feeder fan is fixed inside the mixing tank for facilitating easy and faster mixing of manure with water for making homogenous slurry.

GAS OUTLET PIPE

The Gas Outlet Pipe is made of GI pipe and fixed on top of the drum at the centre in case of floating biogas holder BGP and on the crown of the fixed dome BGP. From this pipe the connection to gas pipeline is made for conveying the gas to the point of utilisation. A gate valve is fixed on the gas outlet pipe to close and check the flow of biogas from plant to the pipeline.

3.9.7 Functioning of a Simple India Rural Household Biogas Plants (BGPs)

The fresh organic material (generally in a homogenous slurry form) is fed into the digester of the plant from one end, known as Inlet. Fixed quantity of fresh material fed each day (normally in one lot at a predetermine time) goes down at the bottom of the digester and forms the ‘bottom-most active layer’, being heavier then the previous day and older material. The decomposition (fermentation) takes place inside the digester due to bacterial (microbial) action, which produces biogas and digested or semi-digested organic material. As the organic material ferments, biogas is formed which rises to the top and gets accumulated (collected) in the Gas Holder (in case of floating gas holder BGPs) or Gas Storage Chamber (in case of fixed dome BGPs). A Gas Outlet Pipe is provided on the top most portion of the Gas Holder (Gas Storage Chamber) of the BGP. Alternatively, the biogas produced can be taken to another place through pipe connected on top of the Gas Outlet Pipe and stored separately. The Slurry (semi-digested and digested) occupies the major portion of the digester and the Sludge (almost fully digested) occupies the bottom most portion of the digester. The digested slurry (also known as effluent) is automatically discharged from the other opening, known as Outlet, is an excellent bio-fertilizer, rich in humus. The anaerobic fermentation increases the ammonia content by 120% and quick acting phosphorous by 150%. Similarly the percentage of potash and several micro-nutrients useful to the healthy growth of the crops also increase. The nitrogen is transformed into Ammonia that is easier for plant to absorb. This digested slurry can either be taken directly to the farmer’s field along with irrigation water or stored in a Slurry Pits (attached to the BGP) for drying or directed to the Compost Pit for making compost along with other waste biomass. The slurry and also the sludge contain a higher percentage of nitrogen and phosphorous than the same quantity of raw organic material fed inside the digester of the BGP.

3.9.7.1 Type of Digestion

The digestion of organic materials in simple rural household biogas plants can be classified under three broad categories. They are (i) Batch-fed digestion (ii) Semi-continuous digestion and (iii) Semi-batch-fed digestion.

BATCH-FED DIGESTION

In batch-fed digestion process, material to be digested is loaded (with seed material or innouculam) into the digester at the start of the process. The digester is then sealed and the contents left to digest (ferment). At completion of the digestion cycle, the digester is opened and sludge (manure) removed (emptied). The digester is cleaned and once again loaded with fresh organic material, available in the season.

SEMI-CONTINUOUS DIGESTION

This involves feeding of organic mater in homogenous slurry form inside the digester of the BGP once in a day, normally at a fixed time. Each day digested slurry; equivalent to about 85-95% of the daily input slurry is automatically discharged from the outlet side. The digester is designed in such a way that the fresh material fed comes out after completing a HRT cycle (either 55, 40 or 30 days), in the form of digested slurry. In a Semi-continuous digestion system, once the process is stabilized in a few days of the initial loading of the BGP, the biogas production follows a uniform pattern.

SEMI-BATCH FED DIGESTION

A combination of batch and semi-continuous digestion is known as Semi-batch fed Digestion. Such a digestion process is used where the manure from domestic farm animals is not sufficient to operate a plant and at the same time organic waste like, crop residues, agricultural wastes (paddy & weed straw), water hyacinths and weeds etc, are available during the season. In as Semi-batch fed Digestion the initial loading is done with green or semi-dry or dry biomass (that can not be reduced in to slurry form) mixed with starter and the digester is sealed. This plant also has an inlet pipe for daily feeding of manure slurry from animals. The Semi-batch fed Digester will have much longer digestion cycle of gas production as compared to the batch-fed digester. It is ideally suited for the poor peasants having 1-2 cattle or 3-4 goats to meet the major cooking requirement and at the end of the cycle (6-9 months) will give enriched manure in the form of digested sludge.

3.9.7.2 Stratification (Layering) of Digester due to Anaerobic Fermentation

In the process of digestion of feedstock in a BGP many by-products are formed. They are biogas, scum, supernatant, digested slurry, digested sludge and inorganic solids. If the content of Biogas Digester is not stirred or disturbed for a few hours then these by-products get formed in to different layers inside the digester. The heaviest by-product, which is Inorganic Solids will be at the bottom most portion, followed by Digested Sludge, and so on and so forth as shown in the three diagrams for three different types of digester.

BIOGAS

Biogas is a combustible gas produced from the anaerobic digestion of organic matter. Comprising 55-70% Methane, 30-45% Carbon Dioxide, 1-2% of Hydrogen Sulphide and traces other gases.

LAYERING		USEFUL FRACTIONS
Gas	BIOGAS	Combustible gas

Fibrous	SCUM	Fertilizer
Liquid	SUPERNATANT	Biologically Active
Semi Solid	DIGESTED SLUDGE	Fertilizer
Solid	INORGANIC SOLIDS	Waste

Diagram 1. By-Product of Batch Fed Digester

LAYERING		USEFUL FRACTIONS
Gas	BIOGAS	Combustible gas
Fibrous	SCUM	Fertilizer
Liquid	DIGESTED SLURRY	Fertilizer
Liquid	SLURRY IN DIFFERENT STAGES OF FERMENTATION	Biologically Active
Solid	INORGANIC SOLIDS	Waste

Diagram 2. By-Product of Semi-Continuous Fed Digester

LAYERING		USEFUL FRACTIONS
Gas	BIOGAS	Combustible gas
Fibrous	SCUM	Fertilizer
Liquid	DIGESTED SLURRY (EFFLUENT)	Fertilizer
Liquid	MIXTURE OF SUPERNATANT AND SLURRY IN DIFFERENT STAGES OF FERMENTATION	Biologically Active
Semi solid	DIGESTED SLUDGE	Fertuilizer
Solid	INORGANIC SOLIDS	Waste

Diagram 3. By-Product of Semi-batch Fed Digester

SCUM

Mixture of coarse fibrous and lighter material that separates from the manure slurry and floats on the top most layer of the slurry is called Scum. The accumulation and removal of scum is sometimes a serious problem. In moderate amount scum can’t do any harm and can be easily broken by gentle stirring, but in large quantity can lead to slowing down biogas production and even shutting down the BGPs.

SUPERNATANT

The spent liquid of the slurry (mixture of manure and water) layering just above the sludge, in case of Batch-fed and Semi Batch-fed Digester, is known as Supernatant. Since supernatant has dissolved solids, the fertiliser value of this liquid (supernatant) is as great as that of effluent (digested slurry). Supernatant is a biologically active by-product; therefore must be sun dried before using it in agricultural fields.

DIGESTED SLURRY (EFFLUENT)

The effluent of the digested slurry is in liquid form and has its solid content (total solid-TS) reduced to approximately 10-20% by volume of the original (Influent) manure (fresh) slurry, after going through the anaerobic digestion cycle. Out of the three types of digestion processes mentioned above, the digested slurry in effluent-form comes out only in semi-continuous BGP. The digested slurry effluent, either in liquid-form or after sun drying in Slurry Pits makes excellent bio-fertilizer for agricultural and horticultural crops or aquaculture.

SLUDGE

In the batch-fed or semi batch-fed digester where the plant wastes and other solid organic materials are added, the digested material contains less of effluent and more of sludge. The sludge precipitates at the bottom of the digester and is formed mostly of the solids substances of plant wastes. The sludge is usually composted with chemical fertilizers as it may contain higher percentage of parasites and pathogens and hookworm eggs of etc., especially if the semi-batch digesters are either connected to the pigsty or latrines. Depending upon the raw materials used and the conditions of the digestion, the sludge contains many elements essential to the plant life e.g. Nitrogen, Phosphorous, Potassium plus a small quantity of Salts (trace elements), indispensable to the plant growth- the trace elements such as boron, calcium, copper, iron, magnesium, sulphur and zinc etc. The fresh digested sludge, especially if the night soil is used, has high ammonia content and in this state may act like a chemical fertiliser by forcing a large dose of nitrogen than required by the plant and thus increasing the accumulation of toxic nitrogen compounds. For this reason, it is probably best to let the sludge age for about two weeks in open place. The fresher the sludge the more it needs to be diluted with water before application to the crops, otherwise very high concentration of nitrogen my kill the plants.

INORGANIC SOLIDS

In village situation the floor of the animals shelters are full of dirt, which gets mixed with the manure. Added to this the collected manure is kept on the unlined surface which has plenty of mud and dirt. Due to all this the feed stock for the BGP always has some inorganic solids, which goes inside the digester along with the organic materials. The bacteria can not digest the inorganic solids, and therefore settles down as a part of the bottom most layer inside the digester. The Inorganic Solids contains mud, ash, sand, gravel and other inorganic materials. The presence of too much inorganic solids in the digester can adversely affect the efficiency of the BGP. Therefore to improve the efficiency and enhance the life of a semi-continuous BGP it is advisable to empty even it in a period of 5-10 years for thoroughly cleaning and washing it from inside and then reloading it with fresh slurry.

3.9.8 Classification of Biogas Plants (BGPs)

The simple rural household BGPs can be classified under the following broad categories- (i) BGP with Floating Gas Holder, (ii) BGP with Fixed Roof, (iii) BGP with Separate Gas Holder and (iv) Flexible Bag Biogas Plants.

3.9.8.1 Biogas Plant with Floating gas Holder

This is one of the common designs in India and comes under the category of semi-continuous-fed plant. It has a cylindrical shaped floating biogas holder on top of the well-shaped digester. As the biogas is produced in the digester, it rises vertically and gets accumulated and stored in the biogas holder at a constant pressure of 8-10 cm of water column. The biogas holder is designed to store

50% of the daily gas production. Therefore if the gas is not used regularly then the extra gas will bubble out from the sides of the biogas holder.

3.9.8.2 Fixed Dome Biogas Plant

The plants based on Fixed Dome concept was developed in India in the middle of 1970, after a team of officers visited China. The Chinese fixed dome plants use seasonal crop wastes as the major feed stock for feeding, therefore, their design is based on principle of 'Semi Batch-fed Digester'. However, the Indian Fixed Dome BGPs designs differ from that of Chinese designs, as the animal manure is the major substrate (feed stock) used in India. Therefore all the Indian fixed dome designs are based on the principle of 'Semi Continuous-fed Digester'. While the Chinese designs have no fixed storage capacity for biogas due to use of variety of crop wastes as feed stock, the Indian household BGP designs have fixed storage capacity, which is 33% of the rated gas production per day. The Indian fixed dome plant designs use the principle of displacement of slurry inside the digester for storage of biogas in the fixed Gas Storage Chamber. Due to this in Indian fixed dome designs have 'Displacement Chamber(s)', either on both Inlet and Outlet sides (like Janata Model) or only on the Outlet Side (like Deenbandhu or Shramik Bandhu Model). Therefore in Indian fixed dome design it is essential to keep the combined volume of Inlet & Outlet Displacement Chamber(s) equal to the volume of the fixed Gas Storage Chamber, otherwise the desired quantity of biogas will not be stored in the plant. The pressure developed inside the Chinese fixed dome BGP ranges from a minimum of 0 to a maximum of 150 cm of water column. And the maximum pressure is normally controlled by connecting a simple Manometer on the pipeline near the point of gas utilisation. On the other hand the Indian fixed dome BGPs are designed for pressure inside the plant, varying from a minimum of 0 to a maximum of 90 cm of water column. The Discharge Opening located on the outer wall surface of the Outlet Displacement Chamber and automatically controls the maximum pressure in the Indian design.

3.9.8.3 Biogas Plant with Separate Gas Holder

The digester of this plant is closed and sealed from the top. A gas outlet pipe is provided on top, at the centre of the digester to connect one end of the pipeline. The other end of the pipeline is connected to a floating biogas holder, located at some distance to the digester. Thus unlike the fixed dome plant there is no pressure exerted on the digester and the chances of leakage in the Main Unit of the Plant (MUP) are not there or minimised to a very great extent. The advantage of this system is that several digesters, which only function as digestion (fermentation) chambers (units), can be connected with only one large size gas holder, built at one place close to the point of utilisation. However, as this system is expensive therefore, is normally used for connecting a battery of batch-fed digesters to one common biogas holder.

3.9.8.4 Flexible Bag Biogas Plant

The entire Main Unit of the Plant (MUP) including the digester is fabricated out of Rubber, High Strength Plastic, Neoprene or Red Mud Plastic. The Inlet and Outlet is made of heavy duty PVC tubing. A small pipe of the same PVC tubing is fixed on top of the plant as Gas Outlet Pipe. The Flexible Bag Biogas Plant is portable and can be easily erected. Being flexible, it needs to be provided support from outside, up to the slurry level, to maintain the shape as per its design configuration, which is done by placing the bag inside a pit dug at the proposed site. The depth of the pit should as per the height of the digester (fermentation chamber) so that the mark of the initial slurry level is in line with the ground level. The outlet pipe is fixed in such a way that its outlet opening is also in line with the ground level. Some weight has to be added on the top of the

bag to build the desired pressure to convey the generated gas to the point of utilisation. The advantage of this plant is that the fabrication can be centralised for mass production, at the district or even at the block level. Individuals or agencies having land and some basic infrastructure facilities can take up fabrication of this BGP with small investment, after some training. However, as the cost of good quality plastic and rubber is high which increases the comparative cost of fabricating it. Moreover the useful working life of this plant is much less, compared to other Indian simple Household BGPs, therefore inspite of having good potential, the Flexible Bag Biogas Plant has not been taken up seriously for promotion by the field agencies.

3.9.9 Common Indian Biogas Plant (BGP) Designs

The three of the most common Indian BGP design are- (i) KVIC Model, (ii) Janata Model and (iii) Deenbandhu Model, which are briefly described in the subsequent paragraphs:

3.9.9.1 KVIC Model

The KVIC Model is a floating biogas holder semi continuous-fed BGP and has two types, viz. (i) Vertical and (ii) Horizontal. The vertical type is more commonly used and the horizontal type is only used in the high water table region. Though the description of the various components mentioned under this section are common to both the types of KVIC models (Vertical and Horizontal types) some of the details mentioned pertains to Vertical type only. The major components of the KVIC Model are briefly described below:

FOUNDATION

It is a compact base made of a mixture of cement concrete and brick ballast. The foundation is well compacted using wooden ram and then the top surface is cemented to prevent any percolation & seepage.

Digester (Fermentation Chamber)

It is a cylindrical shaped well like structure, constructed using the foundation as its base. The digester is made of bricks and cement mortar and its inside walls are plastered with a mixture of cement and sand. The digester walls can also be made of stone blocks in places where it is easily available and cheap instead of bricks. All the vertical types of KVIC Model of 4 M3 capacity and above have partition wall inside the digester.

GAS HOLDER

The biogas holder drum of the KVIC model is normally made of mild steel sheets. The biogas holder rests on a ledge constructed inside the walls of the digester well. If the KVIC model is made with a water jacket on top of the digester wall, no ledge is made and the drum of the biogas holder is placed inside the water jacket. The biogas holder is also fabricated out of fibre glass reinforced plastic (FRP), high-density polyethylene (HDP) or Ferroconcrete (FRC). The biogas holder floats up and down on a guide pipe situated in the centre of the digester. The biogas holder has a rotary movement that helps in breaking the scum-mat formed on the top surface of the slurry. The weight of the biogas holder is 8-10 kg/m2 so that it can stores biogas at a constant pressure of 8-10 cm of water column.

INLET PIPE

The inlet pipe is made out of Cement Concrete (CC) or Asbestos Cement Concrete (ACC) or Pipe. The one end of the inlet pipe is connected to the Mixing Tank and the other end goes inside the digester on the inlet side of the partition wall and rests on a support made of bricks of about 1 feet

height.

OUTLET PIPE
The outlet pipe is made out of Cement Concrete (CC) or Asbestos Cement Concrete (ACC) or Pipe. The one end of the outlet pipe is connected to the Outlet Tank and the other end goes inside the digester, on the outlet side of the partition wall and rests on a support made of bricks of about 1 feet height. In the case KVIC model of 3 M3 capacity and below, there is no partition wall, hence the outlet pipe is made of short and horizontal, which rest fully immersed in slurry at the top surface of the digester.

BIOGAS OUTLET PIPE
The Biogas Outlet Pipe is fixed on the top middle portion of the biogas holder, which is made of a small of GI Pipe fitted with socket and a Gate Valve. The biogas generated in the plant and stored in the biogas holder is taken through the gas outlet pipe via pipeline to the place of utilisation.

3.9.10 Janata Model
The Janata model consists of a digester and a fixed biogas holder (known as Gas Storage Chamber) covered by a dome shaped enclosed roof structure. The entire plant is made of bricks and cement masonry and constructed underground. Unlike the KVIC model, the Janata model has no movable part. A brief description of the different major components of Janata model is described below:

Foundation
The foundation is well-compacted base of the digester, constructed of brick ballast and cement concrete. The upper portion of the foundation has a smooth plaster surface.

Digester
The digester is a cylindrical tank resting on the foundation. The top surface of the foundation serves as the bottom of the digester. The digester (fermentation chamber) is constructed with bricks and cement mortar. The digester wall has two small rectangular openings at the middle, situated diametrically opposite, known as inlet and outlet gate, one for the inflow of fresh slurry and the other for the outflow of digested slurry. The digester of Janata BGP comprises the fermentation chamber (effective digester volume) and the gas storage chamber (GSC).

Gas Storage Chamber (GSC)
The Gas Storage Chamber (GSC) is also cylindrical in shape and is the integral part of the digester and located just above the fermentation chamber. The GSC is designed to store 33% (approx. 8 hours) of the daily gas production from the plant. The Gas Storage Chamber (GSC) is constructed with bricks and cement mortar. The gas pressure in Janata model varies from a minimum of 0 cm water column (when the plant is completely empty) to a maximum of up to 90 cm of water column when the plant is completely full of biogas.

Fixed Dome Roof
The hemi-spherical shaped dome forms the cover (roof) of the digester and constructed with brick and cement concrete mixture, after which it is plastered with cement mortar. The dome is only an enclosed roof designed in such a way to avoid steel reinforcement. (Note: The gas collected in the dome of a Janata plant is not under pressure therefore can not be utilised. It is only the gas stored in the Gas Storage Chamber (GSC) portion of the digester and that is under pressure and can be

said as utilisable biogas).

Inlet Chamber
The upper portion of the Inlet Chamber is in the shape of bell mouth and constructed using bricks and cements mortar. Its outer wall is kept inclined to the cylindrical wall of the digester so that the feed material can flow easily into the digester by gravity. The bottom opening of the Inlet Chamber is connected to the Inlet Gate and the upper portion is much wider and known as Inlet Displacement Chamber (IDC). The top opening of the inlet chamber is located close to the ground level to enable easy feeding of fresh slurry.

Outlet Chamber
It is a rectangular shaped chamber located just on the opposite side of the inlet chamber. The bottom opening of the Outlet Chamber is connected to the Outlet Gate and the upper portion is much wider and known as Outlet Displacement Chamber (ODC). The Outlet Chamber is constructed using bricks and cement mortar. The top opening of the Outlet Chamber is located close to the ground level to enable easy removal of the digested slurry through a discharge opening. The level of the discharge opening provided on the outer wall of the outlet chamber is kept at a somewhat lower level than the upper mouth of the inlet opening, as well as kept lower than the Crown of the Dome ceiling. This is to facilitate easy flow of the digested slurry out the plant in to the digested slurry pit and also to prevent reverse flow, either in the mixing tank through inlet chamber or to go inside the gas outlet pipe and choke it.

Biogas Outlet Pipe
The Biogas Outlet Pipe is fixed at the crown of the dome, which is made of a small length of GI Pipe fitted with socket and a Gate Valve.

3.9.10.1 Deenbandhu Model
The Deenbandhu Model is a semi continuous-fed fixed dome Biogas plant. While designing the Deenbandhu model an attempt has was made to minimise the surface area of the BGP with a view to reduce the installation cost, without compromising on the efficiency. The design essentially consists of segments of two spheres of different diameters joined at their bases. The structure thus formed comprises of (i) the digester (fermentation chamber), (ii) the gas storage chamber, and (iii) the empty space just above the gas storage chamber. The higher compressive strength of the brick masonry and concrete makes it preferable to go in for a structure that could be always kept under compression. A spherical structure loaded from the convex side will be under compression and therefor, the internal load will not have any effect on the structure.
The digester of the Deenbandhu BGP is connected with the Inlet Pipe and the Outlet Tank. The upper part (above the normal slurry level) of the outlet tank is designed to accommodate the slurry to be displaced out of the digester (actually from the gas storage chamber) with the generation and accumulation of biogas and known as the Outlet Displacement Chamber (ODC). The Inlet Pipe of the Deenbandhu BGP replaces the Inlet Chamber of Janata Plant. Therefore to accommodate all the slurry displaced out from the Gas Storage Chamber (GSC), the volume of the Outlet Chamber of Deenbandhu model twice the volume of the Outlet Tank of the Janata BGP of the same capacity.
Being a fixed dome technology, the other components and their functions are same as in the case of Janata Model BGP and therefore are not elaborated here once again.

3.9.10.2 Shramik Bandhu Model

This new BRCM biogas plant model which is also a semi-continuous hydraulic digester plant was designed by the author and christened as SHRAMIK BANDHU (friend of the labour). Since then, three more models (rural household plants) in the family of SHRAMIK BANDHU Plants have also been developed. The second one, a semi-continuous hydraulic digester, works on the principle of semi-plug flow digester (suitable for use as a Night Soil based or Toilet attached plant). The third one uses simple low cost anaerobic bacterial filters, designed for possible application as a Low Cost and low Maintenance Wastewater Treatment System. The fourth one is a semi-batch fed hydraulic digester, ideally suitable for the regions where plenty of seasonal crop wastes and waste green biomass are available and population of domestic farm animals are less, for producing the desired quantity of biogas from it alone. For this reason the first model which is the simplest and cheapest in the family of Shramik Bandhu plants, is christened as SBP-I Model. The other three models, yet to be field evaluated, are, SBP-II, SBP-III and SBP-IV, respectively.
The family of SHRAMIK BANDHU biogas plants designs uses the fixed dome concepts as in the case of pervious two most popular Indian fixed dome plants, namely, Janata and Deenbandhu models. In other words, all the four Models of the family of SHRAMIK BANDHU Plant have both, (i) the Gas Storage Chamber (GSC) and (ii) the Dome shaped Roof. However, in this section, the description about Shramik Bandhu plants relates to SBP-I model only.

The SHRAMIK BANDHU Plant is made of Bamboo Reinforced Cement Mortar (BRCM), by pre-fabricated bamboo shells, using the correct size mould for a given capacity SBP-I model- Thus, completely replacing the bricks. These bamboo shells are made by weaving bamboo strips (weaving of which can be done in the village itself) for casting a BRCM structure. The BRCM structures on the one hand are used for giving the right shape to this plant, while on the other hand acts as the reinforcement to the cement mortar plaster as it is casted more or less like the ferro-cement structure. In order to protect the bamboo strips from microbial attack, they are pre-treated by immersing them in water mixed with prescribed ratio of Copper Sulphate (CuSO4) for a minimum of 24 hours before weaving of shell structure is done. As a further safety measure DPC powder in appropriate quantity is mixed while doing second layer (coat) of smooth plastering on the Main Unit of the Plant (MUP), Outlet Chamber (OC); as well as other BRCM components and sub-components, to make the entire structure of SBP-I moisture proof. The Shramik Bandhu plant made from BRCM would be much stronger because it has both higher tensile, as well as compressive strength, as compared to either First Class Bricks or Cement Concrete (CC) or Cement Mortar (CM), when used alone. The reason for this is that the bamboo shell structures used (for both reinforcement and shape of the plant) for the construction of Shramik Bandhu plant is made by weaving strips [only the outer harder surface (skin) and not the softer inner part of bamboo] from seasoned (properly cured) bamboo. Therefore, the entire structure (body) of the SBP-I model would be very strong, durable and have long useful working life. The two previous fixed dome models, namely Janata and Deenbandhu model have no reinforcement and are made of Bricks and Cement Mortar only, therefore, while they are very strong under compression but cannot withstand high tensile force. The hemi-spherical shell shaped (structure) of SHRAMIK BANDHU (SBP-I) model loaded from top on its convex side will be under compression. However, due to comprehensive strength provided by both cement mortar, as well as the reinforcement provided by the woven bamboo shell will ensure that the internal and external load will not have any residual effects on the structure. The bamboo reinforcement will provide added strength (both tensile and compressive) to make the entire structure of SHRAMIK BANDHU

(SBP-I) model very sound, as compared to the previous two fixed dome Indian models (Janata & Deenbandhu), referred above.
The digester of SBP-I model is connected to the slurry mixing tank with inlet pipe made of 10 cm or 100 mm (4") diameter Asbestos Cement Concrete (ACC) pipe, for feeding the slurry inside the plant.
The Outlet Displacement Chamber (ODC) is designed to accommodate the slurry to be displaced out of the digester with the generation & accumulation of biogas. The Outlet Displacement Chamber (ODC) of SBP-I model is also kept hemi-spherical in shape to reduce it's surface area for a given volume (to save in building materials and time taken for construction)- The ODC is also made of BRCM, using a hemi-spherical shaped woven bamboo shell structure.
A Manhole opening of about 60 cm or 600 mm (2.0 Ft) diameter is provided on the crown of the hemi-spherical shaped ODC. The Manhole is big enough for one person to go inside and come out, at the same time small enough to be able to easily close it by a same size Manhole Cover, which is also made of BRCM.

COMPONENTS OF SHRAMIK BANDHU (SBP-I MODEL) BIOGAS PLANT (BGP)
The Shramik Bandhu (SBP-I) Model is made of two major components and several minor components and sub-components. They are categorized as, (a) Main Unit OF The Plant (MUP), (b) Outlet Chamber (OC) and (c) Other Minor Components. These major and minor components are further divided into sub-components, as given below:
Main Unit Of the plant (MUP)
The Main Unit of the Plant (MUP) is one of the major components of Shramik Bandhu (SBP-I) Model. The MUP has following six main "Sub-Components":
(i). Digester {or Fermentation Chamber (FC)}
(ii). Gas Storage Chamber (GSC)
(iii). Free Space Area (FSA), located just above the GSC
(iv). Dome (Roof of the Plant-entire area located just above the FSA); and
(v). The following three other sub-components:
[{(e)-(i) the Foundation of the MUP & (e)-(ii)} the Ring Beam for MUP (these two have also been considered here as the two sub-components of the MUP} and {the third is (e)-(iii) the Gas Outlet Pipe (GIP), for better explanation & understanding of the constructional aspects of SBP-I Plant].

Outlet Chamber
The Outlet Chamber (OC)) is the second major component of Shramik Bandhu (SBP-I) Model. The OC has the following four main "Sub-Components":
(i). Outlet Tank (OT)
(ii). Outlet Displacement Chamber (ODC)
(iii). Empty Space Area (ESA) above the ODC- though for all practical purpose the ODC includes the Empty Space Area (ESA) above it; however, from the designing point of view, the effective ODC of SBP-I model is considered up to the starting of discharge opening located on its outer wall
(iv). Discharge Opening (DO)

Minor Components of the SBP-I Plant
The Minor Components of the Shramik Bandhu (SBP-I) Model are as follows:
(i). Inlet Pipe (IP)
(ii). Outlet Gate (OG)

(iii). Mixing Tank (MT) or Slurry Mixing Tank (SMT)
(iv). Short Inlet Channel (SIC)
(v). Gas Outlet Pipe (GOP)
(vi). Grating (made of Bamboo Sticks)
(vii). Manhole Cover (MHC) for ODC

Being a fixed dome technology, the components and their functions are same as in the case of Janata and Deenbandhu Model BGP and therefore not elaborated here once again.

3.10 Conversion of biomass into electricity

Historically one of the earliest alternatives to fossil fuels is a wood fired boiler producing steam which powers an engine driving a generator. This, unfortunately is about the only advantage. But the steam power has all the disadvantages of an engine/generator and even several more. The wood must be chopped and carried, cured, split, and fed, just as for any wood stove. Ashes must be handled and hauled. The entire installation requires constant control while it is running. Due to compounds in some of the feedstocks, “slagging and fouling” can occur. Slagging is accumulation of solid residues on parts of the combustion system. Fouling is simply the accumulation of liquid or semi-liquid residue. This is an important aspect of plant operation and operators need to understand how biomass differs from more commonly used fuels.

3.10.1 Gasification

Usually, electricity from biomass is produced via the condensing steam turbine, in which the biomass is burned in a boiler to produce steam’ which is expanded through a turbine driving a generator. The technology is well-established, robust and can accept a wide variety of feedstocks. However, it has a relatively high unit-capital cost and low operating efficiency with little prospect of improving either significantly in the future. There is also the inherent danger in steam. Steam occupies about 1200 times the volume of water at atmospheric pressure (known as “gage” pressure). Producing steam requires heating water to above boiling temperature under pressure. Water boils at 100° C at sea level. By pressurizing the boiler it is possible to raise the boiling temperature of water much higher. Elevating steam temperature has to be done to use the generated steam for any useful work otherwise the steam would condense in the supply lines or inside the cylinder of the steam engine itself.

Gasification is the newest method to generate electricity from biomass. Instead of simply burning the fuel, gasification captures about 65-70% of the energy in solid fuel by converting it first into combustible gases. This gas is then burned as natural gas is, to create electricity, fuel a vehicle, in industrial applications, or converted to synfuels-synthetic fuels. Since this is the latest technology, it is still under development.

A promising alternative is the gas turbine fuelled by gas produced from biomass by means of thermochemical decomposition in an atmosphere that has a restricted supply of air. Gas turbines have lower unit-capital costs, can be considerably more efficient and have good prospects for improvements of both parameters.

Biomass gasification systems generally have four principal components:
(a) Fuel preparation, handling and feed system;
(b) Gasification reactor vessel;
(c) Gas cleaning, cooling and mixing system;
(d) Energy conversion system (e.g., internal-combustion engine with generator or pump set, or gas

burner coupled to a boiler and kiln).

When gas is used in an internal-combustion engine for electricity production (power gasifiers), it usually requires elaborate gas cleaning, cooling and mixing systems with strict quality and reactor design criteria making the technology quite complicated. Therefore, “Power gasifiers world-wide have had a historical record of sensitivity to changes in fuel characteristics, technical hitches, manpower capabilities and environmental conditions”.

Gasifiers used simply for heat generation do not have such complex requirements and are, therefore, easier to design and operate, less costly and more energy- efficient.. All types of gasifiers require feedstocks with low moisture and volatile contents. Therefore, good quality charcoal is generally best, although it requires a separate production facility and gives a lower overall efficiency.

In the simplest, open-cycle gas turbine the hot exhaust of the turbine, is discharged directly to the atmosphere. Alternatively, it can be used to produce steam in a heat recovery steam generator. The steam can then be used for heating in a cogeneration system; for injecting back into the gas turbine, thus improving power output and generating efficiency known as a steam-injected gas turbine (STIG) cycle; or for expanding through a steam turbine to boost power output and efficiency - a gas turbine/steam turbine combined cycle (GTCC) (Williams & Larson, 1992).

While natural gas is the preferred fuel, limited future supplies have stimulated the expenditure of millions of dollars in research and development efforts on the thermo-chemical gasification of coal as a gas-turbine feedstock. Much of the work on coal-gasifier/gas-turbine systems is directly relevant to biomass integrated gasifier/gas turbines (BlG/GTs). Biomass is easier to gasify than coal and has a very low sulphur content. Also, BIG/GT technologies for cogeneration or stand-alone power applications have the promise of being able to produce electricity at a lower cost in many instances than most alternatives, including large centralized, coal-fired, steam-electric power plants with flue gas desulphurization, nuclear power plants, and hydroelectric power plants.

Gasifiers using wood and charcoal (the only fuel adequately proved so far) are again becoming commercially available, and research is being carried out on ways of gasifying other biomass fuels (such as residues) in some parts of the world. Problems to overcome include the sensitivity of power gasifiers to changes in fuel characteristics, technical problems and environmental conditions. Capital costs can still sometimes be limiting, but can be reduced considerably if systems are manufactured locally or use local materials. For example, a ferrocement gasifier developed at the Asian institute of Technology in Bangkok had a capital cost reduced by a factor of ten. For developing countries, the sugarcane industries that produce sugar and fuel ethanol are promising targets for near-term applications of BIG/GT technologies.

Gasification has been the focus of attention in India because of its potential for large scale commercialization. Biomass gasification technology could meet a variety of energy needs, particularly in the agricultural and rural sectors. A detailed micro- and macroanalysis by Jain (1989) showed that the overall potential in terms of installed capacity could be as large as 10,000 to 20,000 MW by the year 2000, consisting of small-scale decentralized installations for irrigation pumping and village electrification, as well as captive industrial power generation and grid fed power from energy plantations. This results from a combination of favourable parameters in India which includes political commitment, prevailing power shortages and high costs, potential for specific applications such as irrigation pumping and rural electrification, and the existence of an infrastructure and technological base. Nonetheless, considerable efforts are still needed for large-scale commercialization.

3.10.2 CO-FIRING

Co-firing of biofuels (e.g. gasified wood) and coal seems to be the way how to reduce emissions from coal firing power plants in many countries. In 1999 a new co-firing system - biomass and coal - started its operation in Zeltweg (Austria). A 10 MW biomass gasification unit was installed in combination with an existing coal fired power station. The gasifier needs 16 m3 woody biomass (chips and bark) per hour. The calorific value of the gas ranges between 2,5 - 5 MJ/Nm3. The project named “Biococomb” is an EU demonstration project. It was realised by the “Verbund” company together with several other companies from Italy, Belgium, Germany and Austria and co-financed by the European Commission.

3.10.3 COGENERATION

3.10.3.1 Biomass-Fired Gas Turbine

A current trend in industrialized countries is the use of increasing number of smaller and more flexible biomass based plants for cogeneration of heat and electricity. A newly developed biomass cogeneration plant in Knoxville, Tennessee, USA, is at the cutting edge of one of the promising technologies behind this development. The plant combines a wood furnace with a gas turbine. A hot, pressurized flue-gas filter cleans the exhaust gas from the furnace before it drives the power turbine. The plant can run on fresh cut sawdust (40% humidity), and produces 5.8 MW of electricity, while consuming 10 tons sawdust/hour, and delivering heat as hot exhaust gas at 370°C. This gives an electric efficiency of about 19% and overall efficiency of up to about 75%. The exhaust gas can be used in a steam turbine, increasing electric output to 9.6 MW, and electricity efficiency to over 30%. The plant in Knoxville has been operating since spring 1999.

3.11 Guideline for Estimation of Biomass Potentials, Barriers and Effects

3.11.1 Unused Forest Energy Potential & Fuelwood

Most commercial forests in Europe have an unused energy potential, which can be used without endangering their role in the natural eco-systems. Beside this, most forests already have a production of firewood. Mountain forests and other less commercial forests can in certain cases also deliver wood for energy, but only after due environmental consideration.

The available forest residues are generally branches with diameters smaller than 7 cm. Generally, leaves and roots should be left in the forest to preserve a healthy forest environment. They are also more difficult to use for energy than branches.

It is not enough to use more firewood, the efficiency needs to be increased as well: Traditional ovens and furnaces have in many cases efficiencies as low as 30%, compared with about 80% for efficient furnaces. Increased efficiency can thus more than double the energy outcome of wood burning, without using more wood. For larger installations, flue-gas condensation can raise efficiency further. For larger applications, wood furnaces can be replaced with wood gasifiers + gas motors or steam boilers + turbines, for cogeneration of electricity and heat.

Energy content

The energy content in totally dry wood is apr. 5.2 kWh/kg. In normally dry firewood (20% humidity) the energy content is apr. 4.2 kWh/kg (lower heating value). In most statistics, wood is measured in cubic meter solid wood (with or without bark). The density of dry wood varies from 800 kg/m3 for hard leafy wood (e.g. beech) to 600 kg/m3 for coniferous (e.g. pine). This gives energy contents of respectively 3400 and 2500 kWh/m3 for beech and pine (lower heating value,

20% humidity).
For furnaces with flue-gas condensers, the energy output can be 80-90% of the higher heating value, which is respectively apr. 4% and 10% above lower heating values for wood with 20% and 40% humidity.

Resource estimation
The available amount of wood can be estimated from forest statistics as the difference between annual growth (in m3, including bark) and the annual wood extraction for timber and other non-energy purposes. Bark can be estimated to 20% of wood exclusive bark. Often the statistics provide only commercial extraction, to which should be added an estimate of non- commercial use. The non-commercial use is often in the form of firewood-gathering by local inhabitants, and could thus be included in the energy potential. In reality the resource might be lower than this estimate due to problems of extracting all branches and/or due to the need of leaving some branches in the forest for ecological reasons. These two factors can reduce the resource with as much as 50% even in commercial forests.

If forest statistics are incomplete or unreliable, simplified estimates can be made:
* if only figures for commercial use is available, the potential for wood residues can be estimated as a fraction of the commercial use. Danish experience is that wood for wood-chips (branches smaller 7 cm in diameter) is equivalent to 25% of the timber production including bark or 31% of the timber exclusive bark.
* if only forest area is known, a first estimate can be made based on area of commercial forest. An estimate from Germany (BUND) gives an annual growth of forests of 10-15 tonnes/ha with an energy content of 150 - 225 GJ/ha (42 - 63 MWh/ha). If 3/4 of this is used for timber, the available residues has an energy content of 40-60 GJ/ha (11 - 16 MWh/ha). An estimation of residues from forests on the Danish island Bornholm gives practical usable residues smaller than 7 cm in diameter of 1.7 tons/ha, equivalent to 18 GJ/ha (5 MWh/ha) with 40% humidity or 25 GJ/ha (7 MWh/ha) with 20% humidity. These estimates do not take into account the important factors of climate and soil for the actual wood production.

Barriers
Use of firewood for heating does not in general pose barriers. The efficient use of firewood, however, requires efficient ovens and basic knowledge of the users. Using wood-chips requires equipment for producing the wood- chips, storaging, drying, and feeding into an appropriate boiler. This production-chain should be set up locally for successful use of wood-chips for heating. Wood-chips are most suitable in larger boilers, above 100 kW. Often wood-chips have high humidity (40 - 60%), and boilers with flue-gas condensation should be preferred.

Effects on economy, environment and employment
Economy
Use of firewood and wood-chips are based on a local resource, requires minimal transport/import and is therefore quite inexpensive in comparison to fossil fuels.
Price estimates, excluding transport & profits (of leafy trees, density 760 kg/m3):
* Denmark: 240 DKK/m3 equal to 0.11 DKK/kWh (0.0203 $/kWh)
* Danish example with Czech wages: 513 Csk/m3 equal to 0.24 CsK/kWh (0.011 $/kWh)
Of the Danish price 2/3 is wages, while the rest is fuel and machine costs. Of the Czech price 1/3

is wages.

Environment
Use of wood replacing fossil fuels reduces net CO2 emissions, because the forest absorbs the same quantity of CO2, which is released in the later combustion of the wood. The energy to process the wood is in the order of a few percent of its heating value.
Wood combustion emits very little sulphur (SO2) compared with coal and oil. NOx emissions depend on the combustion process and often the lower combustion temperature leads to lower emissions than for coal and oil combustion. Emissions of particulate and unburned hydrocarbons are totally dependent on the combustion processes, and can be a problem in small and badly designed furnaces. Ashes from the combustion can often be used as fertilizer.
It is important that the extraction of wood is done in a sustainable manner, with adequate re-planting etc.

Employment
According to French experience, utilizing of excess energy from forests requires 450 jobs/TWh with the degree of mechanization that is normal for Western Europe.

Hand-rules
Each ha of forest on good soil in Central Europe grows 10 tons/ha of wood. If 25% of this is available as waste-wood for energy, the output for energy is 2.5 tons or 11 MWh (20% humidity).

3.11.2 Residues from wood industry
In saw-mills, pulp mills and all wood processing industries, residues are made that can be used for energy purposes. From saw-mills is mainly bark and saw-dust. From pulp-mills (cellulose and paper production) is black and sulphite liquors as well as wood and bark residues. From sawmills comes edgings, chips, sawdust, bark and other residues. Some of these residues are used for pulping, and particle-and fibreboard. Analysis of 7 countries shows that 30-70% of wood industry residues are used for these non-energy purposes.
The residues in forms of larger pieces can be made into wood- chips for wood-chip boilers, while sawdust can be burned in special furnaces or compressed into wood pellets of brickets, that can be used in smaller furnaces and ovens.
Often wood industry uses their wood residues to meet own energy demands for heating, steam and eventually electricity.

Energy content
The energy content for wood residues are about 4.2 kWh/kg (lower heating value, 20% humidity), equivalent to 3400 and 2500 kWh/m3 for beech and pine respectively. See also previous chapter.

Resource Estimation
Evaluation of wood residues can be based on trade-statistics of non-energy wood and wood-products compared with total extraction from forests. The difference is available for energy purposes, and is probably to some extent already used as such in wood industries.
As a simple estimate can be used that residues in general are 25-35% of total forest removals (e.g. Poland 29%, Canada 29%, Finland 33%, Sweden 36%, USA 37% from Biofuels). If a larger part of forest removals are exported without processing, the figure will be lower.

Barriers

This resource has in general the fewest barriers of all renewable energies. An efficient utilization requires, however, investments in new boilers, or at least in a pre-combustion furnace, that can be attached to an existing (good) boiler.

Effect on economy, environment and employment
When the residues from industry are treated as waste without commercial value, the economy of using them for energy is almost always cost-effective, and has a better economy than wood residues from forests.

Environmental effects are equal to wood residues from forests, as long as combustion of chemically treated and painted wood residues is avoided. Such wood-residues should be treated as municipal waste or chemical waste depending on the treatment.

The direct employment of using industrial wood waste is low because the waste has to be handled anyway. Indirectly it gives considerable employment because it turns unused materials into a valuable product (energy).

3.11.3 Combustible waste from agriculture
Straw, prunings of fruit trees and wine and olive oil residues are all residues from agriculture that can be used for energy purposes. Straw harvest is depending on weather conditions and vary considerably from year to year. The straw surplus has also large variations from year to year. If a large part of the surplus is used, an alternative fuel should be considered for years with little surplus straw. Such an alternative fuel could be wood-chips forest residues, that can be used alternatively with straw in many boilers. The forest residues can stay several years in the forests before usage. Straw surplus can be ploughed into the field for enriching the humus layer of the field. When this is needed for a sustainable agriculture, the surplus straw for energy will be lower.

Energy Content
The energy content of straw is 4.9 kWh/kg of dry matter (high heating value). With a typical of 15% humidity the lower heating value is 4.1 kWh/kg.
The energy in 1 m3 of densely compressed straw bales is 500 kWh (density 120 kg/m3).
The average efficiency for 22 straw-fired heating stations in operation in Denmark is 80-85%, not including flue-gas condensation.

Resource Estimation
Estimations of straw production can be obtained from agricultural statistics. This value should be reduced with agricultural consumption of straw for animal fodder and bedding. The agricultural consumption is very dependent on the type of stables used. In Denmark the average available surplus for energy is estimated to 59% of which 1/5 is already used, mainly for heating (Straw). In Eastern Bohemia, this surplus is estimated to about 35%. As a general, conservative estimate for Europe 25% of the straw production can be used for energy. The straw production varies +/- 30% from average years to years with high respectively low straw harvest.

If straw production is not available from statistics, relatively good estimates can be made from statistics of grain production. As a rough estimate the amount in tons of straw can be equalled to the amount of grain in tons. In the Czech Republic the average ratio between straw and grain is found to:
* wheat 1.3 tons straw/tons grain

* barley 0.8 tons straw/tons grain
* rye 1.4 tons straw/tons grain
* oat 1.1 tons straw/tons grain

A rough estimate can be made based on agricultural area and a straw harvest of 4-7 tons/ha depending on soil, type of grain and weather.

Barriers

Limited experience and funds for the necessary investments are often the largest barriers to use straw for energy. Other barriers can be:

* the need to develop a market for straw with attractive prices for users as well as suppliers,
* pesticides can in certain situations give unwanted chlorine compounds in the straw. This can be reduced by leaving the straw for a period at the field before collection, so called wilting.
* use of straw in inadequate and polluting boilers can give straw a bad reputation.

Effect on economy, environment and employment

Economy

In Denmark, straw-prices vary from 0.085 DKK/kWh (1.2 EURO cent or 1.2 US cent) to 0.12 DKK/kWh for baled straw delivered at a straw-firing station. In Czech Republic the prices for straw collected at the farm has been quoted at 0.043 Csk/kWh (0,15 EURO cent) for loose straw and 0.054 Csk/kWh (0.19 EURO cent) for baled straw.

Costs, average for 16 straw-fired installations in Denmark are per kWh heat produced:

	Danish average	Estimate for Czech Republic
Fuel	1,9 EURO cent	0,26 EURO cent
Electricity*	0,12 EURO cent	0,12 EURO cent
O&M, administr.	1,3 EURO cent	0,26 EURO cent
Capital costs	1,5 EURO cent	1,5 EURO cent
TOTAL	4,8 EURO cent	2,14 EURO cent

* Electricity consumption is in average 2.3% of heat produced

The environmental impact of using agricultural residues are, as for wood, reduced CO2-emission, reduced sulphur emissions, compared with coal and oil. Emissions of particulate, NOx and volatile organic compounds (VOC) depend on furnaces and flue-gas treatment. Chlorine components in straw gives emission of HCl as mentioned above. Danish experience from 13 straw-fires heating stations shows the following emissions (all plants have particulate filters):

Emission	Average Emission g/kWh straw	Variation of emissions g/kWh straw
Particulate	0,14	0,01-0,3
CO	2,2	0,4-4
NOx	0,32	0,14-0,5
SO2	0,47	0,4-0,6
HCl	0,14	0,05-0,3

PAH*	0,6	0,4-1
Dioxin**		1-10 ng

* PAH = Polyaromatic Hydro-Carbons. This is the carcinogenic part of VOCs.
** Dioxin figures are based on only two measurements, figures given in nanogram, 10-9 g.

Employment
The direct employment of harvesting straw in a fully mechanized agriculture in Denmark is estimated to 350 jobs/TWh. This is for technologies with large straw-bales (500 kg each). For a system based on smaller bales (10-20 kg), the employment is larger.

3.11.4 Energy Crops
It is estimated that 20-40 million hectares of land in the EU will be surplus to conventional agricultural requirement. The same situation (agricultural overproduction and setting the land aside) can be expected in Central Europe as well. This set aside land can be used for different purposes, one of them is energy crop production.

Promising crops which can be planted for energy purposes in Europe are short rotation trees (coppice of various willows and poplars), Miscanthus and Sweet Sorghum. These crops can be utilized by direct combustion for heat and electricity production. Other promising energy crops are plants for liquid fuels as rape seeds for bio-oil.

Energy Contents and Yields
The following table gives an overview of the expected yields and energy contents for three of the promising plants for solid fuel production.

	Yields (tonnes/ha/year)	Energy content (GJ/dry tonne)	Energy Yields (GJ/ha/year)
Salix (Willow)*	15	16	240
Miscanthus (Elephant grass)	20	17	340
Sweet Sorghum	25	18	450

*Increment of Salix is 2-3 meters in one year (2-3 cm per day in the summer), harvest every third year.

Another promising plant is hemp, which has yields up to 24 tonnes/hectare in approximately 4 month. Hemp plantation is illegal in many countries, even though some variants has very little content of cannabis.

Resource Estimation
The energy potentials can be estimated from the area of land which is set aside in the country/region and can be used for energy plantation and the expected outcome of the above crops under the actual climate and soil conditions. In most countries, national estimates exists of the different yields of the plants. Using excess farm land and ecologically degraded land should be the

priority.

Important feature in estimation of potential is input : output ratio. If the bagasse of Sweet Sorghum (2/3 of its energy content) and the sugar (1/3 of its energy content) are utilised for energy purposes the input : output (I/O) energy ratio will reach 1:5 . This means that five times more energy is recovered from crop (on fuel basis) in comparison with energy utilised for the seeding, fertilisers and pesticides treatment, harvesting, transport and conversion into useable fuels. Usually the input : output ratio is larger than 1:5 for trees and smaller for plants for liquid biofuels.

Barriers
Short rotation crops may require as much fertilization as traditional crops and degraded land must be regenerated before cultivation using fertilization. For tree crops these drawbacks may be offset by the fact that they retain an active root system throughout the year. Wood ash would be an effective fertilizer for biofuels plantation, reducing the problems caused by the leaching of fertilizers into ground water.

Effect on Economy, Environment and Employment
Economy, Costs
Production costs for Sweet Sorghum are 50 ECU per dry tonne.
Production cost of Salix are 70 ECU (500 DKK) / tonne of dry matter in Denmark (Hvidsed).

Electricity generation cost for biomass (Sweet sorghum) fuelled system (1992) and improved systems (2000).
Small facility : 0,16 EURO/kWh
Large facility : 0,08 EURO/kWh
Small improved : 0,07 EURO/kWh
Large improved : 0,05 EURO/kWh

Environment
An important feature for Salix is that it can be used for water purification - it is possible to grow Salix in purification systems and in the same time harvest the Salix for energy (10-20 tonnes of sludge can be used on each hectare every year). Other benefits of biomass for energy plantation includes forest fire control, improved erosion control, dust absorption, and used as replacement for fossil fuels: no sulphur emission and lower NOx emissions.

Employment
For Sweet Sorghum production cost 50% is manpower cost. Production of about 500 tonnes of dry biomass per year justifies the creation of one new job. Other new jobs could be created in related industries such as composting, pulp for paper, service organisation etc.

Hand Rule
Sweet Sorghum output for trials in different locations of Central and Southern Europe:
Annually 90 tonnes of fresh material = 25 tonnes of dry matter per hectare = 450 GJ or 11 tonnes of oil equivalent can be produced. 1/3 as ethanol from sugars and 2/3 of fuel from bagasse. This corresponds to the absorption of 30-45 tonnes of CO_2 per hectare and per year.
Average yearly electricity consumption of a West European person can be met by growing poplar on 0.25 hectare.

3.11.5 Biogas

The largest potential for biogas is in manure from agriculture. Other potential raw-materials for biogas are:
* sludge from mechanical and biological waste-water treatment (sludge from chemical waste-water treatment has often low biogas potential)
* organic household waste
* organic, bio-degradable waste from industries, in particular slaughter-houses and food-processing industries
Care should be taken not to include waste with heavy metals or harmful chemical substances when the resulting sludge is to be used as fertilizer. These kinds of polluted sludge can be used in biogas plants, where the resulting sludge is treated as waste and e.g. incinerated.

Another biogas source is landfills with large amounts of organic waste, where the gas can be extracted directly from drillings in the landfill, so called landfill gas. Such drillings will reduce uncontrolled methane emission from landfills.

Energy Content
The biogas-production will normally be in the range of 0.3 - 0.45 m3 of biogas (60% methane) per kg of solid (total solid, TS) for a well functioning process with a typical retention time of 20-30 days at 32oC. The lower heating value of this gas is about 6.6 kWh/m3. Often is given the production per kg of volatile solid (VS), which for manure without straw, sand or others is about 80% of total solids (TS).
A biogas plant have a self-consumption of energy to keep the manure warm. This is typically 20% of the energy production for a well designed biogas plant. If the gas is used for co-generation, the available electricity will be 30-40% of the energy in the gas, the heat will be 40-50% and the remaining 20% will be self-consumption.

Resource Estimation
For manure, the available data is often the numbers of livestock. From this can be made an estimation of available manure. While the amount of manure produced from animals depends on amount and type of fodder, some average figures are made for most countries.
The following table shows the figures for Denmark :

Kind of animal	Manure type	Amount (kg/day)	Solid amount (kg/day)	Biogas per animal (m3/day)*	Energy per animal (kWh/yr)
Cow	Slurry	51	5,4	1,6	3400
Cow	Dry	32	5,6	1,6	3400
Sow	Slurry	16,7	1,3	0,46	970
Sow	Dry	9,9	2,9	0,46	970
Hen	Dry	0,66	0,047	0,017	36

Yearly energy output is for biogas plant with 20% average self-consumption and 360 working days. When animals are not in stables around the year, the figure will be smaller. The figures are for milking cows and for sows with breeding pigs under 5 kg.
*biogas with 65% methane

To make an estimation of the yearly production, it should be evaluated how many days per year

the animals are in stables. For large poultry farms and pig-farms it is often the whole year, while cows are in stables from a few months a year to the whole year.

To estimate amount of manure from calfs, pigs and chicken, the following estimates can be used:
* calfs 1-6 month: 25% of milking cows
* other cattle (calfs > 6 months, cattle for meet, pregnant cows): 60% of milking cows
* small pigs, 5-15 kg: 28% of sows with pigs
* fattening pigs > 15 kg: 52% of sows with pigs
* fattening chicken: 75% of hens

Barriers
A number of barriers hold back a large scale development of biogas plants in CEEC:
* commercial technology for agriculture (the largest resource base) is not available and have to be developed from existing prototypes or imported.
* it is difficult to make biogas plants cost-effective with sale of energy as the only income. The most likely applications are when other effects of the sludge-treatment has a value. This can e.g. be better hygiene, easier handling, reduced smell, and treatment of industrial waste.
* little knowledge on biogas technology among planners and decision-makers.

Effect on economy, environment and employment
Economy
The economy of a biogas plant consists of large investments costs, some operation and maintenance costs, mostly free raw materials, and income from sale of biogas or electricity and heat. Sometimes can be added other values e.g. for improved value of sludge as a fertilizer.
In an example from Czech Republic the price for a Czech plant is estimated to about 70,000 US $ for a plant for treatment of manure from 100 cows. This plant will produce about 220 MWh/year + energy for its own heating. This gives an investment of 0.32 US $ per kWh/year. New Danish biogas plants have similar investment figures. It is estimated that a joint-venture of Czech and Danish technology could reduce prices by about 40% (to about 0.2 US $ per kWh/year); but this has not been shown in practice.
Operating and maintenance (O&M) will normally per year be 10-20% of investment costs, but it vary much with organization, wages, type of plant and eventual transport of sludge. If O&M is 10% of investment costs, simple pay-back requirement is 10 years and no price can be set to increased value of the sludge, the resulting energy price will be 0.04-0.06 US $/kWh or 0.03 - 0.045 ECU/kWh (based on the above examples from Czech Republic).

The environmental effects of biogas plants are:
* production of energy that can replace fossil fuels, reducing CO2 emissions
* reduce smell and hygiene problems of sludge and manure
* treatment of certain kinds of organic waste that would otherwise pose an environmental problem
* reduce potential methane emissions from uncontrolled anaerobic degradation of the sludge.
* easier handling of sludge, which can increase the fraction used as fertilizer and facilitate a more accurate use as fertilizer

Employment
The direct employment of biogas plants are for Denmark estimated to 560 jobs/TWh, of which 420 jobs/TWh are operating and maintenance, while 140 job/TWh are construction (2000 man-years to

construct plants producing 1 TWh and with lifetime of 14 years). This estimate will be valid for mechanized systems with some degree of centralization: some of the manure is transported to the biogas plant from nearby farms.

3.12 LITERATURE - BIOMASS

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TOP

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biofuel · Biofuels, Journey to Forever: how to make your own biofuel, biodiesel, ethanol, bioenergy, distillation, renewable energy

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Description

Category: Energy

The Biofuel mailing list is for anyone who is making their own fuel or has an interest in biofuels - all aspects of biofuels use are covered.

There are resources, FAQs, how-to's, full recipes and an online Biofuels Library at the Journey to Forever website, the premier source of small-scale biofuels information:

Biofuels
http://journeytoforever.org/biofuel.html

Biodiesel
http://journeytoforever.org/biodiesel.html

Biodiesel - "Where do I start?"
http://journeytoforever.org/biodiesel_make.html#start

Straight vegetable oil (SVO)
http://journeytoforever.org/biodiesel_svo.html

Biofuels Library
http://journeytoforever.org/biofuel_library.html

Ethanol
http://journeytoforever.org/ethanol.html

To send messages:
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List home:
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All messages are archived at the independent Info-Archive at NNYTech - fast, one-time searching and NO ADS:
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Best wishes

Journey to Forever
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What's New

New within the last seven days:

Messages: **159**

Group Info

Members: **2906**
Founded: **Mar 23, 2000**
Language: **English**

Group Settings

- Listed in directory
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- Email attachments are not permitted

Message History

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	810	863	761	796	1129	1325	822	734				
2003	920	1207	1699	1121	761	774	711	897	946	852	627	680
2002	600	742	727	596	833	642	734	750	744	759	855	941
2001	652	517	808	711	1697	913	632	613	567	485	464	675
2000			14	92	77	85	85	46	175	540	332	372

Group Email Addresses

For more information: http://journeytoforever.org/

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ID	Date	Sender	Subject
4124	2004-01-28	Keith Addison	[biofuels-biz] Biofuels-biz list closing
4123	2004-01-28	Keith Addison	[biofuels-biz] Biofuels-biz list closing
4122	2004-01-26	girl mark	[biofuels-biz] new US small producer/distributor/co-op discussion...
4121	2004-01-28	Keith Addison	[biofuels-biz] EPA "guidelines" - was Re: [biofuel] Request
4120	2004-01-26	jennifer	[biofuels-biz] Re: [Burnveggies] NBB fee structure discriminates ...
4119	2004-01-26	blexdt	[biofuels-biz] Re: Coconut and Palm Kernel Oil STD antagonists.
4118	2004-01-26	girl mark	[biofuels-biz] minor correction to NBB fee structure post
4117	2004-01-26	girl mark	[biofuels-biz] NBB fee structure discriminates against small prod...
4116	2004-01-25	Ken Gotberg	Re: [biofuels-biz] Re: Coconut and Palm Kernel Oil STD antagonist...
4115	2004-01-24	blexdt	[biofuels-biz] Re: Coconut and Palm Kernel Oil STD antagonists.
4114	2004-01-23	murdoch	[biofuels-biz] Citing Fire Risk, U.S. to Expand California Loggin...
4113	2004-01-19	Ken Gotberg	Re: [biofuels-biz] A Better Way to Get From Here to There: A Comm...

4112	2004-01-21	Keith Addison	Re: [biofuels-biz] PLEASE READ: Commercial production - was Re:
4111	2004-01-21	EERE Network News (by way of Keith	[biofuels-biz] EERE Network News -- 01/21/04
4110	2004-01-20	girl_mark_fire	[biofuels-biz] Lessons from Bay Area biodiesel distributors?
4109	2004-01-21	Keith Addison	[biofuels-biz] Re: [biofuel] ending of biofuels-biz list
4108	2004-01-20	jamie_lutch	[biofuels-biz] Re: ending of biofuels-biz list and the discussion...
4107	2004-01-20	Keith Addison	[biofuels-biz] Re: [biofuel] ending of biofuels-biz list and the ...
4106	2004-01-19	Ken Gotberg	Re: [biofuels-biz] What are you playing at the pump for dino?
4105	2004-01-21	Keith Addison	[biofuels-biz] Re: ending of biofuels-biz list and the discussion...

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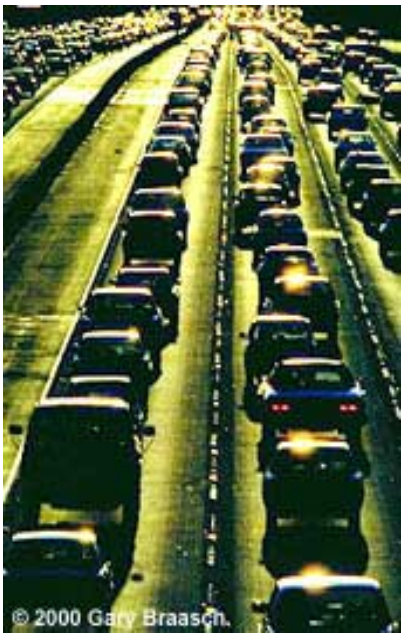

- 70 million motor vehicles were on the world's roads in 1950
- 630 million motor vehicles were on the world's roads in 1994
- 1 billion motor vehicles are expected to be on the world's roads by 2025, if the current growth rate continues
- 12,000 pounds of carbon dioxide are emitted by the average car each year
- 5 percent of a car's fuel can be wasted by underinflated tires
- 2 billion gallons of gasoline could be saved annually if 65 million car owners kept their tires properly inflated
- 85 percent of auto fuel is consumed just to overcome inertia and start the wheels turning
- 2.5 times more emissions are generated by SUVs and light trucks than by standard cars
- 33,000 natural gas vehicles were in use in the U.S. in 1993
- 75,000 natural gas vehicles were in use in the U.S. in 1998
- 50 million new cars roll off the assembly line each year
- 11 million cars are junked annually in the U.S.

-- by Josh Sevin

Sources: 1-3 -- World Resources Institute; 4 -- Environmental Working Group; 5,6 -- *50 Simple Things You Can Do to Save the Earth*; 7 -- *Amicus Journal*; 8 -- *L.A. Times*; 9,10 -- U.S. Department of Transportation; 11 -- *Amicus Journal*; 12 -- *Wall Street Journal.*

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Josh Sevin lives in Cambridge, Mass., where he is a graduate student in MIT's planning program. Previously, he was an editor at Greenwire *environmental news service and a researcher for* U.S. News.

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3R's in the Home

FACTS & STATS ON CARS

Emissions
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Emissions

- Every liter of gasoline burned produces about 2.5 kilograms of CO2. ["Bad Car-ma?" .The ULS Report July/ August 1997. Vol. II, Number 4]
- 20% of all CO2 emissions in the U.S. come from cars. ["The greening of Detroit". Business week. April 8, 1991]
- Cars annually discharge 10 million of carbon into the air, this is expected to rise 25 per cent by the end of the decade. - Earth Keeper [" Environmental Facts to Make You React". Region of Peel]
- In 1990, automobiles continued to be among the most important sources of CO2 in Canada, accounting for almost 11% of our total emissions. [A state of the Environment Fact Sheet No. 93-1 "Environmental implications of the automobile" Environment Canada therein: References: Jacques, A. 1992 Canada's greenhouse gas emissions for 1990. Ottawa: Environment Canada, Conservation and Protection]
- It has been estimated that a 16- km trip taken in light traffic and requiring 11 minutes would produce 2g of VOCs; the same trip in heavy traffic and requiring 30 minutes would generate 7g- a 250% increase. [Go Green (Greater Vancouver Regional District, B.C. Transit, EC, B.C. Ministry of Transportation and Highways) 1990. Facts about motor vehicles and air pollution. 6 pp.]
- Because even clean burning cars produce 20 pounds of carbon dioxide for every gallon of gas they burn, they are the biggest single source of greenhouse gases, which threaten to raise temperatures worldwide. ["Cars sick automobiles ad nauseam" by Robert Schaeffer in Greenpeace Vol. 15 No. 3 May/ June 1990]
- Transportation contributes about 30% of total greenhouse gas emissions from human activity and is the fastest growing source of such emissions [City of Toronto, Healthy City Office, *Evaluating the Role of the Automobile*: *A Municipal Strategy*. (September 1991, reprinted May 1992)]
- Geenhouse gas emissions by mode passenger transport (Grams of carbon dioxide equivalent per

passenger kilometre)

MODE	GRAMS
New catalyst car	**197**
Diesel car	**161**
Bus	**69**
Diesel train	**79**
Electric train	**76**
Local train	**54**
Aircraft	**853**

- [National Round Table on the Environment and the Economy, State of the Debate: Sustainable Transportation in Canada, (July 3, 1997, Final Draft).]
- The new coating replaces paints that contain as much as 85 per cent solvent- all of which evaporates when it is sprayed on to the air.[Toronto Star, Oct. 12 1992]
- It's estimated that North America's 70,000 body repair shops each year emit about 100,000 tonnes of these solvent VOCs. The chemicals contribute to smog, which causes respiratory and other health problems in humans, and also damage vegetation and agricultural crops.[Toronto Star, Oct.12 1992]
- Nitrogen oxides:
  69% of all Nitrogen Oxide
  30% of all Particulates emissions come from vehicles
  92% of all Carbon Monoxide is emitted from cars, trucks, buses and other vehicles
  Cars, trucks and buses account for 74% of all hydrocarbons
  [The Lung Association. The Facts: Air Pollution. Better Breathing Program]
- Motor vehicles are the single largest source of air pollution, casting a pall over the world's cities.
- Automobiles are also a major source of carbon dioxide, the greenhouse gas responsible for over half of the global warming trend, accounting for more than 13 percent of the worldwide total.
- Pollution Emitted from Urban Transport Modes, for Typical Work Commutes, United States:

Mode	Hydrocarbons Carbon Monoxide Nitrogen Oxides (grams per 100 passenger miles)		
Rapid rail	0.3	2	49
Light rail	0.4	3	69
Transit bus	20	305	154

Van pool	36	242	38
Car pool	70	502	69
Auto (one occupant)	209	1,506	206

Based on national average vehicle occupancy rates.

Sources: American Public Transit Association, Mass Transit: "The Clean Air Alternative", Washington, D.C. 1989 found in: ["Out of the car, into the future" by Marcia D. Lowe. WW, Nov/Dec 1990]

- Cars are the largest single source of carbon dioxide (CO2), by far the most prevalent global warming gas.
- Cars and light trucks make up the single largest source of Canadian CO2 emissions. ["New campaign to stop cars from fueling global warming" - Earth Words Vol.2 No 4 Nov. 1990]
- Each car spills a witches' brew of dangerous gases into the air each year, including an average of:
  4,000 kilograms of carbon dioxide
  300 kilograms of carbon monoxide
  30 kilograms of nitrogen oxide
  35 kilograms of ozone-forming hydrocarbons as well as lesser amounts of methane, lead and particulates
- Canadian cars and trucks emit about 98 million tonnes of CO2 each year- approximately 23% of the national total of CO2 emissions.
- Burning a single tank of gasoline releases 140 to 180 kilograms of carbon dioxide into the atmosphere.
- The average North American car pumps its own weight in CO2 into the atmosphere each year.
- Cars and trucks are also responsible for approximately
  *17% of the nitrogen oxides released into the air,
  *58% of the carbon monoxide, and
  *55% of the volatile organic carbon
  ["Transportation and Global Warming". Pollution Probe]
- Ontario has operated a pilot project in Mississauga, the Clean Air Test Centre, where 13,000 cars were tested in the past year. More than 20 per cent about 2,600 - failed to meet minimum emission standards. ["Coming: Summer and smog" by Brian McAndrew. The Toronto Star St., May 11, 1996]
- (Used June 26, 98) Technicians found that one poorly-tuned vehicle can emit pollutants equivalent to 20 other cars.["Driving clean: Cuts Smog & saves you $". Ministry of Environment and Energy]
- The tailpipe exhaust from the vehicles we drive contain many different pollutants, including carbon dioxide, a "greenhouse gas" linked to global warming, and other toxic chemicals that are hazardous to health. It also contains pollutants that cause smog, one of our most serious and visible air pollution problems.
- If everyone maintained their cars regularly, together we could reduce nitrogen oxides by 12 per cent and volatile organic compounds by 30 per cent.
- A car traveling an average of 16,000 kilometres a year can produce more than four tonnes of

pollutants annually, including three-and-a-half times its weight in carbon dioxide emissions. It also produces other contaminants such as waste, oil and antifreeze.

- As much as one-third of these emissions (carbon dioxide) come from cars and light vehicles.["Driving clean: Cuts Smog & saves you $". Ministry of Environment and Energy]
- Automotive fuels account for 17% of global carbon dioxide releases, two thirds as much as rainforest destruction.[Paving Moratorium; found in "Transporting Ourselves to Economic Growth" by Sue Zielinski: facts.html at kows.web.net]
- Motor vehicles account for about 25 percent of U.S. carbon dioxide emissions. (In Canada, about 23 percent.) For every gallon of gasoline consumed by an automobile, about 19 pounds (2.3 kilograms per liter) of carbon dioxide are emitted. In a year, the typical American car pumps almost 5 tons (4.5 metric tons) of carbon dioxide into the atmosphere. [Car Trouble and Teacher's Guide to World Resources 1992-93, reprinted from the Teacher's Guide to World Resources 1994-95, World Resources Institute: "Cars: How Do Motor Vehicles Contribute to Air Pollution?". found in: www.wri.org/wri/enved/car/tgc-air.html]
- If you travel 20000 km a year, you produce about 5 tonnes of air pollution. Thats your contribution to global warming and acid rain. ["Bike week challenge '93" by Mike Buckthought, found in AUTO FREE ZONE Issue 5 oct-dec 1993: http://www.flora.ottawa.on.ca/afo/]
- Ozone (a gas formed as nitrogen oxides and hydrocarbons from exhaust react with sunlight), the major component of smog, is believed to reduce soybean, cotton, and other crop yields by 5 to 10 percent. ["Out of the car, into the future" by Marcia D. Lowe. WW, Nov/Dec 1990]
- Air pollution, much of it caused by smog, adds an extra $1 billion each year to Canada's health costs, according to federal estimates.
- In the GTA, 17 per cent of ozone comes from automobiles.["Coming: Summer and smog" by Brian McAndrew. The Toronto Star St., May 11, 1996]
- The air conditioning in cars produces CFC's. CFC's have been discovered to be a major cause of the breakdown of the ozone layer, which shields the earth from the harmful effects of the sun's ultraviolet radiation.
- It is estimated that a one percent reduction in high-level ozone results in a four per cent increase in human skin cancers. As well, ozone thinning has been linked to suppressed human immune systems and to possible DNA damage causing mutation and birth defects.
- Canada is responsible for only two percent of global ozone depletion. However, on a per capita basis, we are the second highest contributor to global ozone depletion, after the United States. [BMW. Aug 21, 1991]
- They (smog pollutants) are also known to harm crops, vegetation and wildlife, corrode materials and damage buildings and property. ["Driving clean: Cuts Smog & saves you $". Ministry of Environment and Energy]
- Motor vehicle air conditioners are the world's single largest source of CFC leakage into the atmosphere, and subsequent destruction of the ozone layer. [Paving Moratorium; found in "Transporting Ourselves to Economic Growth" by Sue Zielinski: facts.html at www.kows.web.net]
- One CFC molecule can destroy as many as 100,000 ozone molecules. [Car Trouble and Teacher's Guide to World Resources 1992-93, reprinted from the Teacher's Guide to World Resources 1994-95, World Resources Institute: "Cars: How Do Motor Vehicles Contribute to Air Pollution?". found in: www.wri.org/wri/enved/car/tgc-air.html]

- Approximately 90 per cent of the CFCs used in automobiles are in the form of air conditioning refrigerant (CFC-12). Canada: proposed a ban on their use in automobiles by 1995. ["Wanted: recyclables cars, 'green' air conditioning". The Toronto Star.Nov.,23, 1991]
- Auto emissions have been linked to the declining health of forests. For example, ground level ozone, formed by photo-breakdown of auto emissions, can cause plant injury as far as 120 to 200 km from the origin of the primary pollutants. Conifers and some deciduous trees are damaged by concentrations of ozone equal to or less than what is commonly experienced in many Canadian urban areas. ["Cars cause tree trouble". Earth Words. Vol. 5 No. 4 1993]
- Virtually all of the CFCs and halons that have ever been released are still in the atmosphere - Earth Keeper [" Environmental Facts to Make You React". Region of Peel]

Canada/ Canadians

- Transportation in Canada is on an unsustainable path with a projected increase in fossil fuel consumption (and consequently greenhouse gas emissions) increasing by 40% over the next 25 years even when advances in technology and regulations are accounted for
- Road vehicles are responsible for more than 80% of oil use for transportation and there is little sign of a positive change ["The role of the automobile in Canada". Transportation in Canada- Fact sheet (August, 1997). Pollution Probe]
- The 14- million cars on Canada's roads each pump four tonnes of pollutants into the air every year.[Canadian Press, June 5 '96]
- More than 10 million Canadians own a car; many of them own two.
- The first car rolled out of the factory in 1885. By 1910 there were 5,900 cars on Canada's muddy roads. By 1930 That number had grown to more than one million cars and 160,000 trucks. In 1980, there were 10.2 million Canadian cars, and in just eight years that number had grown by nearly another two million. The number of cars and trucks in Canada is growing by a little more than 2% a year. ["Transportation and Global Warming". Pollution Probe]
- More than 12 million cars now traverse Canada's roads
  -one for nearly every two Canadians, one of the highest ratios of car ownership in the world. Each of these cars travels, on average, more than 16,000 km per year, a total of some 200 billion kilometres, or more than 1,000 times the distance between the Earth and the sun. ["Environmental implications of the automobile". SOE Fact Sheet No.93-1. Environment Canada, 1993]
- Air pollution was the biggest pollution concern for 42 per cent of Canadians. Only 14 per cent placed water pollution first. ["Coming: Summer and smog" by Brian McAndrew. The Toronto Star St., May 11, 1996]
- Canadian "do-it-to-yourselfers" annually discard 300 million litres of used motor oil into the environment ["We are # 1 Canadians lead the world". Earth Words. Vol.5 No. 4 1993]

Ontario

- Over 65,400 SkyDome-fulls of carbon dioxide gas are released in Ontario every year. ["SkyDOME-fulls of environmental wastes". by Burkhard Hausberg. August 20, 1991]
- Despite considerable progress by the auto sector to reduce emissions, cars and trucks are still the largest single local source of smog forming emissions in the urban areas of Southern Ontario [National Round Table on the Environment and the Economy, State of the Debate: Sustainable Transportation in Canada, (July 3, 1997, Final Draft).]
- In Ontario, more than half the nitrogen oxides and one third of volatile organic compounds come from car and truck exhaust.

- Ontario has six million vehicles, almost half the nation's total.
- By 2005, the number of vehicles on Ontario's roads is expected to rise to seven million. The trend to live in outlying communities and drive to work is expected to increase long-distance travel from 91 billion kilometres a year in 1995 to 140 billion by 2020. ["Driving clean: Cuts Smog & saves you $". Ministry of Environment and Energy]
- Each year over 400,000 Ontario automobiles are taken of the road. Yearly only 35% are properly dismantled, reused and recycled.["Reincarnate: new RCO program targets auto disposal". RCO update Vol. 16, No. 5. July 23, 1996]

Toronto

- According to the Blue Ribbon Committee Report, the proportion of particulate emissions from vehicles in the City of Toronto was 37.5 per cent in 1990. Thus, vehicles are a significant part of the particulate problem as far as the health of millions of people living in urban areas is concerned. ["For cleaner air". By Ken Oglivie. Globe, June 24]
- Four out of five automobiles on the road during Toronto rush hour traffic contain a single occupant. [FuelSaver and MTEEAC News, Ontario Ministry of Transportation]
- The number of vehicles crossing the Metro boundary during the morning rush hour has increases by 159% between 1975 and 1991 from 113,741 to 294,181, and by 20% in the downtown core area
- 84% of the people coming into metro to work arrive by car in the past 30 years, the number of car trips per person, per day, has almost doubled over the past 25 years. Vehicle trips in the GTA have increased at twice the rate of the population in 1990.
- Cars are the largest cause of accidental death in Metro Toronto ["The role of the automobile in metro Toronto". Transportation in Canada- Fact sheet (August, 1997). Pollution Probe]
- Between 1975 and 1991, the number of persons entering Metropolitan Toronto by vehicle in the morning rush hour period increased from 113,741 to 294,181, an increase of 159% [City of Toronto, Department of Public Health, Environmental protection Office, *Outdoor Air Quality in Toronto: Issues and Concerns*, (November 1993)]
- Motor vehicles contribute 93% of CO to Toronto air: 502,619 tonnes/ year (in 1985 values) [City of Toronto, Department of Public Health, Environmental protection Office, *Outdoor Air Quality in Toronto: Issues and Concerns*, (November 1993)]
- It was estimated that everyday in 1990, motor vehicles in the GTA emitted:
  *16.5 kilotonnes of CO2
  *63 tonnes of NOx (nitrogen oxides)
  *103 tonnes of VOC (volatile organic compounds)
  [City of Toronto, Healthy City Office, *Evaluating the Role of the Automobile*: *A Municipal Strategy.* (September 1991, reprinted May 1992)]
- The Ontario Ministry of the Environment has rated Toronto's air as being worse than that of Atlanta, Boston or Chicago [The Lung Association. The Facts: Air Pollution. Better Breathing Program]
- The Greater Toronto Area, with its high concentration of industry and denser population, is home to three million (vehicles).["Driving clean: Cuts Smog & saves you $". Ministry of Environment and Energy]

Comparisons

- A commuter train carrying 80 passengers requires roughly 710 British thermal units (Btu) of energy per passenger per mile, and a trolley with 55 passengers uses around 1,050 Btu per passenger mile, and a one person car, some 7,380.
- Public transport also saves valuable city space. Buses and trains carry more people in each vehicle, and if they operate on their own right-of-way (particularly in underground tunnels), can safely run at much higher speeds. An underground metro can carry 70,000 passengers past a certain point in a single lane in one hour, surface rapid rail can carry up to 50,000 people, and a trolley or a bus in a separate lane more than 30,000. A lane of private cars with four occupants, by contrast, can move only about 8,000 people per hour. ["Out of the car, into the future" by Marcia D. Lowe. WW, Nov/Dec 1990]

Urban Densities and Commuting Choices, Selected Cities, 1980:

City	Land Use Intensity (population + jobs/ acre)	Private Car	Public Transport (percent of workers using)	Walking and Cycling
Phoenix	5	93	3	3
Washington	9	81	14	5
Sydney	10	65	30	5
Toronto	23	63	31	6
Amsterdam	30	58	14	28
Stockholm	34	34	46	20
Munich	37	38	42	20
Tokyo	69	16	59	25
Hong Kong	163	3	62	35

Source: Peter Mewman and Jeffrey Kenworthy, Cities and Automobile Dependence: An International Sourcebook (Gower Publishing: Aldershot, England 1989) found in: ["Out of the car, into the future" by Marcia D. Lowe. WW, Nov/Dec 1990]

Costs

- Few U.S. drivers realize that, including fuel, maintenance, insurance, depreciation, and finance charges on their cars, they pay $34 for every 100 miles of driving. On a yearly basis, it costs the

average solo commuter nearly $1,700 just to get to work. By contrast, the average public transport fare is $14 per 100 miles. ["Out of the car, into the future" by Marcia D. Lowe. WW, Nov/Dec 1990]

- The first step is to bring to light the hidden costs of driving, such as air pollution, municipal services, and road construction and repair. Perhaps least-recognized of these public expenses are items such as police, fire, and ambulance services required for an automobile-centered system. According to an analyses of the salaries and personnel time of the Pasadena Police Department in California, 40 percent of department costs are from accidents, theft, traffic control, and other automobile-related items. Extending this finding to the entire United States suggests that local governments spend at least $60 billion on automobiles. Employer-provided free parking (a tax-free fringe benefit) represents another huge subsidy to drivers, variously estimated to be worth an additional $12 to $50 billion a year. ["Out of the car, into the future" by Marcia D. Lowe. WW, Nov/Dec 1990]
- The Metro Toronto Board of Trade calculates that traffic congestion costs two billion dollars per year to Ontario businesses. [Ross Snetsinger, portfolio; found in: "Transporting Ourselves to Economic Growth" by Sue Zielinski: facts.html at www.kows.web.net]
- The United States spends nearly $200 million per day building and rebuilding roads [Paving Moratorium; found in: "Transporting Ourselves to Economic Growth" by Sue Zielinski: facts.html at www.kows.web.net]
- The Ontario Ministry of Transportation has estimated that the societal costs of automobile accidents causing injury and death exceed $1.9 billion per year, including health costs, policing, repairs, lost wages, and other impacts. This is equivalent to roughly $380 per taxpayer per year. [Udo Stillich, p. 11; found in: "Transporting Ourselves to Economic Growth" by Sue Zielinski: facts.html at www.kows.web.net]

Health

- A Health Canada study of 20 years worth of Metro Toronto hospital records ending in 1990 estimated two or three deaths daily - mostly among the elderly - could be linked to periods of high air pollution.
- A poll in January showed 64 per cent of Canadians believe their health is affected by pollution. Only 49 per cent thought so in 1989.
- Forty-two per cent of Canadians and 46 per cent of Americans believe their health problems will increase during the next 10 years because of automobile emissions pollution.["Coming: Summer and smog" by Brian McAndrew. The Toronto Star St., May 11, 1996]
- The summit was told a Health Canada study between 1979-1990 suggests the death rate from lung and heart disease in Toronto increased between two or four per cent during periods of heavy air pollution. That means between 200 and 400 extra deaths a year, primarily in the very young or elderly with existing heart or respiratory problems. [Canadian Press, June 5 ‘96]
- Smog pollutants have been linked to the incidence of allergies, asthma chronic bronchitis and other respiratory and heart ailments.
- A recent Health Canada study showed that six per cent of respiratory admissions in Ontario hospitals during the summer month can be attributed to ozone and sulphate levels, with the largest impact on infants (15 per cent). Other studies have shown similar, and even stronger effects.["Driving clean: Cuts Smog & saves you $". Ministry of Environment and Energy]
- Approximately 47,000 people are killed each year on US roads, similar to the number that died in

the entire Vietnam war. Also in the US, thirty thousand additional death per year are caused by motor vehicle emissions [Paving Moratorium].

- Ontario has 1200 traffic fatalities and almost 120,000 injuries annually [Environment Canada found in: "Transporting Ourselves to Economic Growth" by Sue Zielinski: facts.html at www.kows.web.net]

Energy

- The energy equivalent of 575,000 barrels of oil a day are required to produce 10 million cars in the U.S. . [Greenpeace International (1991) found in: "The Recycling of Automobiles: A Study of the Scope of the "by Mike Carriere / file industry sectors automotive]
- DOT (Department of Transportation [U.S.]) says the average one-way commute is about 10 miles. To accomplish this flat, a 3000- pound car with a single occupant uses about 65,000 BTUs of energy. It would be roughly 3,5 times more energy-efficient to travel in a four-person carpool; 7 times more efficient to go by bus; 35 times more efficient to go by subway; 60 times more efficient to go by train. ["Motion sickness" Friends of the earth. Vol. 21 No. 2 Spring 1991]
- It has been estimated that between 66 and 105 gigajoules of energy are needed to produce a motor vehicle, depending on the proportion of recycled materials used. This is equivalent to the energy contained in between 2000 and 3000 l of gasoline, or the amount of fuel consumed by 16000 to 26000 km of driving. [A state of the Environment Fact Sheet No. 93-1 "Environmental implications of the automobile" Environment Canada therein: References: Jacques, A. 1992 Canada's greenhouse gas emissions for 1990. Ottawa: Environment Canada, Conservation and Protection]

A comparison of energy use by transportation mode

Transportation mode	Fuel electricity use (L/100 km)	Number of commuters	Energy use (MJ/person-km)
Automobile	10 7	1 4 1 4	3.16 0.79 2.21 0.55
Diesel bus	56	40	0.52
Subway	2.61 kWh/km	75 (per car)	0.13

[Modified from Healthy city Office 1991. Evaluation the role of the automobile: a municipal strategy. Toronto: Healthy City Office, City of Toronto and the Technical Workgroup on Traffic Calming and Vehicle Emission Reduction]

- The US consumes 40% of the world's gasoline. US reserves of oil will be depleted by 2020, and world resources by 2040. In the next decade new US oil will require more energy for extraction than is obtained from the oil itself. [Paving Moratorium; found in "Transporting Ourselves to Economic Growth" by Sue Zielinski: facts.html at kows.web.net]

Waste

- In Canada and the United States: People throw away 260 million tires a year. ["Bad Car-ma?"

.The ULS Report July/ August 1997. Vol II, Number 4]

- Perhaps one-fourth of the content by weight of 10 million vehicles retired annually in the U.S. ends up as auto shredder residue (ASR), which is disposed of in landfills. ASR consists of glass, fiber, rubber, auto fluids, dirt- and virtually all plastics found in autos. ["Auto part recycling is a top industry priority". Modern Plastics. March 1992]
- More than eight million vehicles are scrapped annually in Canada and the U.S.
- Materials in vehicles that cannot be recycled is known as fluff. The average fluff per scrapped auto is 547 pounds. In 1989 shredding operations in North America generated 2.4 million tons of fluff that could not be recycled. ["Canadian Automotive Report: Metals in autos 90% cannibalized". Windsor Star/ Tue 24 Mar. 92]
- Every single scrapped car still produces 250 to 300 kilos or waste that, for want of a solution, is effectively thrown away. That's why every year ELVs contribute more than 100 million kilos to the waste mountain. ["Recycling private cars in the Netherlands. A new concept becomes reality".Auto Recycling Nederland BV. Amsterdam, December 1993]
- Each year the auto service industry must dispose of 200 million scrap tires, 15 million batteries and 800 million gallon of lubricants. Add to this list of hazardous materials used in servicing and repairing automobiles: paints, antifreeze, solvents, sealants, aerosols, adhesives, sheet metal and oil filters. [USA Today, Sept. 12, 1991]
- Ontario disposes of 400,000 cars in each year.
- Corroded steel, decaying rubber and 20 liters of operating fluids per car are contaminating the environment in which they are stored. ["Council promotes reincarnation of old automobiles". RCO. News release]
- At least 650 million liters of used motor oil are disposed of improperly each year. One liter of used oil can contaminate one million liters of groundwater. ["Bad Car-ma?" .The ULS Report July/ August 1997. Vol II, Number 4]
- Approximately 425 million litres of used motor oil are discarded in Canada every year, yet only 25 per cent of this oil is re-refined and reused - Harmony Foundation [" Environmental Facts to Make You React". Region of Peel]
- Of the estimated 230 million litres of waste motor oil generated by motor vehicles in 1990, approximately 50% was rerefined and 34% was used as fuel to power incinerators and furnaces. The remaining 16%- over 36 million litres - is believed to have been disposed of in ways that allow environmental contamination, including dumping in landfills and sewers and use as a dust suppressant [unpublished data, Environment Canada, Office of Waste Management]
- An estimated 19.5 million vehicle tires are discarded every year in Canada, about 13 million of which come from passenger vehicles [Canadian Council of Ministers of Environment 1990. Inventory and management of used tires. Canadian Council of Ministers of Environment, Working group on used tires.]
- If it can be assumed that 10 million vehicles are retired in the U.S each year, the total annual quantity is 20 million tons. This is equivalent to about 15 percent as much as municipal solid waste disposal in 1984. ["Characterization of municipal solid waste in the United States, 1960 to 2000". Final Report 1986. Franklin Associates, Ltd.] at least 51,550 tons of ASR/ waste/ year in Ontario [OARA/ RCO 1997]
- Each car produced in Germany (where environmental standards are among the world's highest), produces 25,000 kg of waste and 422 million cubic metres of polluted air in the extraction of raw materials alone, say the Heidelberg researchers. The transport of these raw materials to Germany

and around the country to factores produces a further 425 million cubic metres of polluted air and 12 litres of crude oil in the oceans of the world (for each year).

- Each car, say the Germans, produces 26,5 tonnes of rubbish to add to the enormous problems of disposal and landfill management faced by most local authorities. [...] [Oekobilanz eines Autolebens. Umwelt- und Prognoseinstitute Heidelberg. John Whitelegg: "Dirty from cradle to grave". found in: AUO FREE ZONE Issue 6 Jan-March 1994: http://www.flora.ottawa.on.ca/afo]
- A conventional car creates 26 tons of hazardous waste for every ton the vehicle weighs. A battery-powered automobile produces twice as much 52 tons, including a brew of lead and toxic acids. ["Excerpts from Paul Hawken's Declaration of Sustainability" Paul Hawkens is the author of The Ecology of Commerce and our Future and the making of Things (Special to Utne Reader, Sept/Oct 93). found in AUTO FREE ZONE Issue No. 6 Jan-March 1994: http://www.flora.ottawa.on.ca/afo/]

Resources

- Six million tonnes of ore have to be refined every year for car catalytic converters. ["The Environmental impact of the car". Greenpeace 1990 found in: ftp://alternatives.com/library/envgair/car.rpt]
- One tonne of recycled steel saves 1,5 tonnes iron ore and the energy of equivalent of 3,6 barrels of oil. [RCO]
- Among known polluting processes are * Iron and steel making- needs large amount of coal and limestone. A major producer of sulphur dioxide, acids and slag waste.
- materials composition of the car
  most probable composition 1980 and 1990:

Material	**composite car sales weighted 1980**		**composite car sales weighted 1990**	
	kg	wt%	kg	wt%
Low carbon steel	643	50.4	530	46.3
Alloy steel	83	6.5	91	7.9
Cast iron	174	13.6	91	7.9
Aluminium	81	6.3	136	11.9
Copper,brass	12	1.0	6	0.6
Zinc	5	0.4	4	0.3
Lead	10	0.8	8	0.7

Other metals	9	0.7	16	1.4
Rubber	65	5.1	58	5.0
Glass	34	2.6	32	2.8
Polymers	85	6.7	105	9.2
Other non-metals	76	5.9	68	6.0
Totals	**1277**	**100%**	**1145**	**100%**

[Henstock, Design for Recyclability, found in: "The Environmental impact of the car". Greenpeace 1990. ftp//alternatives.com/library/envgair/car.rpt]

- One gallon of gas = 12 trees
  Every time a gallon of gasoline is burned (weight about 9 pounds), about 12 pounds of oxygen are sucked from the air and are spewed out as over 20 pounds of carbon dioxide. In average, it takes 12 trees to absorb and lock away those 20 pounds of CO2. How many people you know are planting dozen of trees to make up for the gallons of gas they burn or not driving instead?
- How far can we drive
  [...] how far an average car could drive if all the carbon emitted from the exhaust was taken up by one "average" tree? [...] The answer was about 37 kilometres per year. At the very peak of its growth rate, say when it's about 30-50 years old, a tree might take up enough carbon to let you drive about 190 kilometres per year. Those calculations were for a typical BC tree. The answer is about 10 to 20 kilometres for folks living in Ontario planting an average Ontario tree [...] [David Sauborn Scott Prof. Mechanical Engineering, University of Victoria in: Globe to Mail Letters to Editor, 2 Sept. 1992; found in AUTO FREE ZONE Issue 2 Jan-March 1993, www.flora.ottawa.on.ca/afo/]
- Each car in its lifetime is responsible for three dead trees and 30 "sick" trees. [...] [Oekobilanz eines Autolebens. Umwelt- und Prognoseinstitute Heidelberg. John Whitelegg: "Dirty from cradle to grave". found in: AUO FREE ZONE Issue 6 Jan-March 1994: http://www.flora.ottawa.on.ca/afo]
- Car production now consumes more resources than any other industry. It uses * 20 per cent of the world's steel production
  * 10 per cent of the aluminium,
  * 35 per cent of the zinc,
  * 50 per cent of the lead and
  * 60 per cent of all natural rubber.
- In addition, over a third of all the world's oil consumption is accounted for by vehicles. [Clive Ponting. A Green History of the World:The Environment and the Collapse of Great Civilizations. St. Martin's Press, New York, 1991/ Chapter 15, "Creating The Affluent Society".found in AUTO FREE ZONE Issue No. 8 July-September 1994: www.flora.ottawa.on.ca/afo/]

Other

- Thirteen million cars and three million trucks are registered in the country- a fleet that could put 85 per cent of the adult population behind the wheel.
- Until recently, Canadians were buying 1.5 million new cars every year, last year the figure was 1.3 million. ["Car makers' goal: lighter, stronger smarter". The Globe and Mail. Sat., April 18, 1992]
- When you add all the expressways, bridges, gas stations and garages, one soon realizes that close to a third of all land in cities goes to accommodate the almighty car. That means one third less space for trees. ["Cars cause tree trouble". Earth Words. Vol. 5 No. 4 1993]
- 2 Buses = 130 people
  100 Cars = 130 people
  [Earth Words Vol.3 No.2 May, 1991]
- 78.7 per cent of automobiles carry only one person - Ministry of Transportation ["Environmental Facts to Make You React". Region of Peel]
- In 1950, there were 50 million cars worldwide, 75 percent of them in the United States. This number doubled by 1960, redoubled by 1970 and redoubled by 1990, an eightfold increase to 400 million cars.
- Americans collectively drive nearly as much as the rest of the world combined. Not only are they the biggest travelers on the planet, they travel interplanetary distances. In 1990 the U.S. auto and truck fleet will travel two trillion miles, the distance to the planet Pluto and back, 364 times.
- One - half of all Americans have put two cars in their garage. ["Cars sick automobiles ad nauseam" by Robert Schaeffer in Greenpeace Vol. 15 No. 3 May/ June 1990]

This document has been produced by:

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Cities around the world are beginning to work with this ice-breaking sustainability approach. It's not research or theory; it is policy and practice. But proper preparations and follow-up are critical for success. WC/FD offers information, discussion space and an open forum for ideas, exchange and collaboration for people who care about sustainable transport and aren't afraid to work at it.

2004 Global Car Free/Days Rethink NEW

Ten years have passed since the first public C/FD challenge was issued in an international conference in Toledo, Spain. We have since seen a certain amount of C/FD activity going on here and there once or twice a year. But what about the actual accomplishments? The impacts on the city? Is it time to look again? We think so, and we believe this is something we should do together.

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Toronto's New Mobility Week Initiative NEW

Toronto in a city with a long tradition not only of virtually all of the traffic and pollution problems that haunt virtually every large city in North America, but also a strong tradition of citizen concern and local action programs. The city's first New Mobility Week is building on this exceptionally broad base to build on and extent the orginal C/FD project. Check it out.

C/FDs in Action

In this section of the site you have one-click access to all of the international, national, and city programs known to us to this date. Are we missing anything important here? And which of these is a good source for information and insight on how to make a C/FD a success. If so, this is the time and place to let us know. (Section to be updated.)

United Nations Car/Free Days Program

The Commons was approached by the UN in 2001 to lead this cooperative program in preparation for the World Summit on Sustainable Development. This program has made some useful first contributions, but now needs to be re-examined, overhauled and redirected in order to achieve its ambitious objectives. Negotiations & hard thinking in process. Your views?

Getting started: Ready, Fire, Aim?

Great idea! But be warned: it is not nearly as easy as may appear at first glance. It is not that it so difficult to organize and do *something* along these lines. Indeed many have, all too often without a great deal of effort - or meaningful accomplishment!. But take courage! Others have managed to do a good job of this in the past, and surely you can too. So let's start to make it work right here.

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Unconstrained by bureaucracy, economic interests or schedules, New Mobility was launched in 1988 as an open international platform for critical discussion, exchanges of materials and views, and diverse forms of cross-border collaboration on the challenging, necessarily conflicted topic of "sustainable transportation and social justice".

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Pioneering new concepts for activists, community groups, entrepreneurs and business; increasing the uncomfort zone for hesitant administrators and politicians; and through our long term world wide collaborative efforts, energy and personal choices, placing them and ourselves firmly on the path to a more sustainable and more just world.

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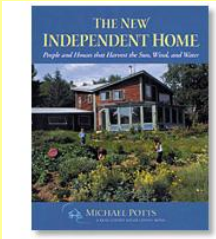

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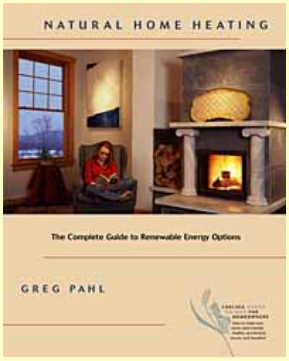

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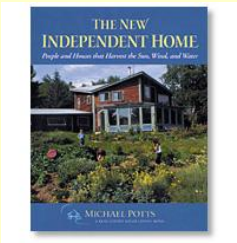	The New Independent Home People and Houses that Harvest the Sun, Wind, and Water by Michael Potts A Real Goods Solar Living Book Chelsea Green Publishing Company

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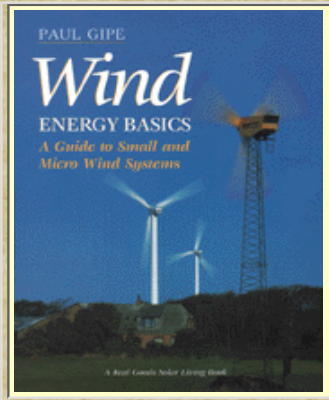

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The Centre for Alternative Technology (CAT): "Located in mid-Wales, CAT is Europe's prime sustainable living demonstration site, exploring and showcasing a wide range of alternative ideas and practices relating to land use, shelter, energy conservation and use, diet and health, waste management and recycling."
New Society Publishers

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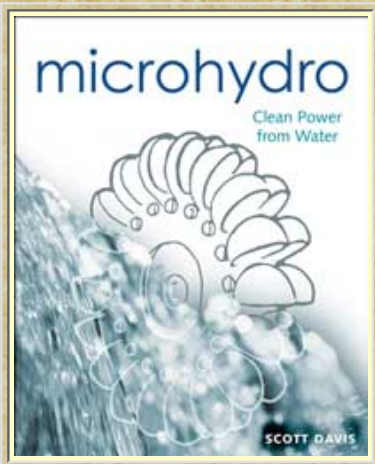

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Clean Power from Water

Scott Davis
New Society Publishers

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Our Building with Earth Solar Journal

HOME

Welcome to the Building with Earth Solar Living 08.28.04 Web Site! Our personal Journal documents our building with earth solar home while we further our sustainable living wisdom.

Our Photo page adds suplementary shots of our land, our building progress, and the local flora & fauna.

Our Links page is for furthering your solar & natural building education along with additional sections for sustainable living, alternative transportation, self discovery, and other links we frequent.

Our future store is our family run business in cottage industry fashion. We give personalized service with products & services for the solar owner-builder. We support small business in every way we can and use recycled packaging whenever possible.

We update frequently, so check back often!

Our Building with Earth quest is now well known clear across the Milkyway galaxy

Instant Mud Home: Just Add Water they say!

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Renewable energy webring

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The renwable energy webring. Sites, both commercial and educational covering hydro power, wind power, wave energy, solar power and thermal energy. Big and small sites which do not just deal with the commercial side, but also help fill in details regarding environmental problems and social effects.

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This site discusses the applications, implementation, advantages, and disadvantages of wind energy as a source of electricity.

Red Rock Energy

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Shawater Ltd.

Shawater are one of the United Kingdoms largest firms specialising in hydro power schemes of up to 10 Megawatts.

singing frog books

On-line bookstore with books on renewable energy plus books on natural building methods, organic gardening, cooking and more. Lots of info, recipes, links and more.

Biofuels: Journey to Forever

Journey to Forever - Hong Kong to Cape Town Overland is a pioneering adventure in environment and development, the first-ever overland expedition from East Asia to Southern Africa - how to make your own clean-burning biofuel, biodiesel from cooking oil, make an advanced

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Shop in a Barn .com will attempt to direct visitors to UK rural venues for environmentally friendly goods and services.

Solar - Let The Sun Shine!

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Sustainable Life

Sustainable Life Eco-Portal - Gateway to a Wealth of Resources, Information & Products To Help You Find What You Need to Live A More Healthy, Socially & Environmentally Sustainable Life

PV Power

This site is a step-by-step documentation of the conversion of a fifty year old home to superinsulated PV powered efficient status and discussion of the issues involved. It is intended to empower people to craft their own incremental pv power system. Mirror site at: http://www.freeyellow

Alternate Energy Resource Network

Find alternate energy resources-sources. Find suppliers world wide. Read alternate energy, fuel cell, global warming, environment and tech-science news. Over 1000 articles and news items, updated daily. Classified Ads, Energy through history, strange energy devices. Find what you need.

Gaiatech living with nature

Worlds simplest pump. It has no moving parts and is powered by falling water. It is inexpensiveand can be made with local skills and local raw materials. Build neat stone walls with or without cement. Aditional (unrelated) environmental information is included on site.

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The SPECMAT proprietary RTWCG process for growing SiO-based coatings, once fully developed, should be an attractive alternative to conventional passivation / antireflective coating techniques for the Si, GaAs and other terrestrial and space solar cell manufacturers.

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Oceanor's Wave Energy Site

Based on our global wave data base (World Wave Atlas)and site specific wave measurements, OCEANOR have carried out a number of wave

energy pre-feasibility and resource studies around the World over the last 15 years. Among these are major studies in the South Pacific, Philippines and Europe.

EcoLiving Center's Energy Message Board

Message board where people from all over the world discuss alternative energy systems: solar, wind, water, fuel cell, etc.

Renewable Webring homepage

Word Whizzyrds

Custom writing, poetry, poetry and graphic arts apparel, cards, posters, wind energy, weBlogs, fantasy poems, stories, and more.

Akeena Solar -- Run Your Electric Meter Backwards

Akeena Solar designs and installs solar electric systems for residences and business customers.

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Biofuels Network

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RingMaster: sspence65

Home > **Science** > **Energy**

About this Ring

The discussion and education in the field of biofuels, meaning fuels made from biological sources. Ethanol, Biodiesel, Methane, and other Biomass based fuels.

Ring Stats

- Created 03/11/2000
- 6 active site(s)
- 1 page views today
- 5590 total page views
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Biofuels: Journey to Forever

Journey to Forever is the first-ever overland expedition from East Asia to Southern Africa, the first to use the Internet to link schools and communities all along the route, and the first to offer online participants and especially schoolchildren everywhere an active role in confronting the environme

Beginners Tour of Biogas

An introduction to anaerobic digestion and the production of biogas.

The Free Information Society

A Website devoted to providing free information on science, history, electronics, computers, and other subjects. Features the internet's largest electrical schematic archive and propaganda archive

Sustainable Life

Sustainable Life Eco-Portal - Gateway to a Wealth of Resources, Information & Products To Help You Find What You Need to Live A More Healthy, Socially & Environmentally Sustainable Life

Alternate Energy Resource Network

Find alternate energy resources-sources. Find suppliers world wide. Read alternate energy, fuel cell, global warming, environment and tech-science news. Over 1000 articles and news items, updated daily. Classified Ads, Energy through history, strange energy devices. Find what you need.

the marriage of green energy and aquaponics

Our green energy program will create fuel, electricity, heat and feed for our aquaponics program

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WELCOME

The girl in this photo is 5 feet tall, and these plants are not trees, they are red raspberry bushes which have been irrigated with fish tank effluent.

9-11-01 - We Will Remember

SEEKING:
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Started in 1989 in upstate New York, the food pantry began by feeding just 2 families who were sent to us by the local school district. Word quickly spread, and within 4 years, the number of families had grown to 6,000 (or about 40,000 people per year, half of whom were children) and we were providing about 1.5 million pounds of food annually for their needs. Our catchment area also grew to 8 counties and 2 states, and we also shared excess food with other food pantries and soup kitchens.

Week after week and month after month we fed the same folks but there was no change occuring in their lives - we felt we were creating dependency. As a result, we started our agricultural educational programming to provide some measure of economic self-sufficiency and - since many of our families were involved in agriculture or owned land - to demonstrate alternative ways of creating additional on-farm income. The projects on this site are our attempt to effect the root causes of hunger and stem the loss of family farms.

So....welcome to our site. We invite you to grab a cup of coffee, look around and explore what we are doing. If you find an educational area you are interested in, or if you are already involved in one of our fields of interest, we would be interested in networking with you. We have spread some helpful tips throughout the site, so be sure to visit every page. Note: the tips are not necessarily in keeping with the theme of each page.

THE UNIVERSITY OF ADELAIDE

An Introduction to BIOGAS

Biogas is generated when bacteria degrade biological material in the absence of oxygen, in a process known as anaerobic digestion. Since biogas is a mixture of methane (also known as marsh gas or natural gas) and carbon dioxide it is a renewable fuel produced from waste treatment. Anaerobic digestion is basically a simple process carried out in a number of steps that can use almost any organic material as a substrate - it occurs in digestive systems, marshes, rubbish dumps, septic tanks and the Arctic Tundra. Humans tend to make the process as complicated as possible by trying to improve on nature in complex machines but a simple approach is still possible, as I hope you see in the links below.

If you are new to biogas/biofuel and anaerobic digestion for waste treatment or fuel production these pages are intended to assist you. If you only need some simple information the first couple of links will be most useful, while the later pages are to help those considering starting a digester project.There is also a safety page.

All information is provided without warranty and should not be used for commercial purposes.

If you do build a digester please remember that you are dealing with bacteria and (hopefully) flamable/explosive gas, so reasonable safety precautions MUST be used. **Seek professional advice for any commercial project!**

A GLOSSARY is now available to assist you with all the new terms you encounter. Try this CONVERTER if you do not understand the units of measurement used.

There are now some pages on specific topics (FAQ's) at the end of the tour and an Expert Panel (but please take the Tour first or read a book!).

Any suggestions/questions are welcome, and may be made by e-mail to Paul Harris.

Alta Vista Translations may help if you have trouble with English and the Expert Panel has people who speak Dutch, Chinese, Spanish and Italian..

Please note that this tour accesses sites authored by a number of people in different locations, I gratefully acknowledege their work but the tour cannot claim any credit or responsibility for their content!

You can start and move through this guided tour by using the .button to go to the next site, or return to this index via the .button.

THE TOUR

A simple introduction to ANAEROBIC DIGESTION

Have a look around the Roseworthy Campus piggery DIGESTER to see what its all about. This is a Continuous Flow Stirred Tank digester, there are other types as well.

Visit the picture gallery to see some of the types and technologies.

You may find a biogas event that you can attend.

A small "plug flow" digester can be made quite cheaply.

If you want to build a digester the best idea is to start small, here is some INFORMATION to assist you and a challenge as well.

To find out about some of the things which influence digester operation (and need to be considered in design) without getting all messy you may like to look at a computer MODEL of a Continuous Flow Stirred Tank digester for piggery effluent.

Adoption of biogas technology in India is studied in Mathias Gustavsson's thesis.

For some more detailed information you need to visit ISAT or BiogasWorks. There are LOTS of other sites as well, tell me your favourite.

You might also look at the Methane Capture and Use WORKBOOK.

Now you are nearly an expert you could also visit GTZ for a look around, or else try PRACTICALLY GREEN, one of many commercial suppliers. For a low technology, integrated view visit the University of Tropical Agriculture Foundation.

If you are interested in solid waste digestion this book chapter may be a good starting point. [Published in a IAWQ sponsored book about anaerobic digestion of the organic fraction of municipal wastes (edited by Prof Joan Alvarez Mata at Barcelona Univ). I review in this chapter the most common (full scale) reactor designs used to digest solid wastes. I tried to combine the scientific and engineering viewpoints in the paper. If you have difficulties opening or reading the file, please request another copy from coauthor Willy.Verstraete or from his secretary Christine.Graveels. Philippe Vandevivere]

There is lots of information, this book titled Biogas Technology in Nepal: A Sustainable Source of Energy for Rural People by Mr. Govinda Devkota may be helpful to you.

A more advanced DESIGN MODEL is available but it requires a number of inputs.

The AgStar program has information and a comprehensive software model to download.

It is good to start small, how about a home sized project?

There are many years of experience in these posts from Les Gornall (thanks for permission to use them , Les) - Measuring Digester Performance and Practical Tests

For younger tourers, particularly if interested in the wider picture, visit Ollies World.

Useful REFERENCES and LINKS (which also contains some of the above sites) provide further information.

And finally a word on SAFETY to complete our tour of introductory sites.
Student projects provide some more information. Luke Jenangi from Papua New Guinea, worked on a small plug flow digester and Rachael Boyd studied AD of Piggery Effluent in England. Simon Knowles has also set up a small CFSTdigester. You may like to read an award wining essay by Tavé van Zyl as well . Todd Purcell has preapared a powerpoint presentation for a school research project.

If you need to you can Get Acrobat Reader (tm) here.
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Special Interest Pages

History
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Still unsure of the answer to your question? Ask our Expert Panel (but read the Tour first, please)!
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---

go to the next site in Beginners Tour of Biogas, or return to the index

This site, owned by Paul Harris, is in the Biofuels Network.

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- *Phone* : +61-8-8303-7880
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Return to:

Paul Harris Home Page
Discipline of Soil and Land Systems
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Page created by Paul Harris, Last updated August 6, 2004

Gateway to Information Products & Services to help you find what you need to live a Healthier, more Socially & Environmentally Sustainable Life

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What is 'Biomass'

Organic matter including trees, agricultural energy crops, crop & timber wastes, aquatic plants, animal wastes, household, municipal & industrial wastes

Bio-Power US

There's 10 gigawatts installed Biopower electricity generation capacity in the US, where Bioenergy accounts for 3% of primary energy production

Bio-Mass Energy

'Biomass' is organic matter and it can be used to produce 'bioenergy' - Sources of suitable biomass include:

Fast-growing Energy crops / Agricultural & Forestry Waste / Organic Municipal & Industrial Waste

Biomass can be burned 'as is' or converted into gas or liquid fuel

Burned 'as is'

Biomass can be burned to produce energy. In timber & paper industries, wood waste is sometimes burnt to produce energy for the manufacturing process or to heat the buildings. Some coal-fired power plants use biomass as a supplementary energy source to reduce emissions.

Biodiesel

Biodiesel is an ester, made using vegetable & animal fats, even recycled cooking oil, or algae . Can be used as diesel additive reducing vehicle emissions or in pure form to fuel vehicles. Heat can chemically convert biomass into oil

Gas - Hydrogen & Methane

High temperatures are used to convert biomass into gas (a mixture of hydrogen, carbon monoxide, & methane) The gas fuels a turbine that turns an electric generator. Biomass decay fernentation also produces methane gas that can be burned to produce heat or power

Ethanol & Methanol

an alcohol, is made by fermenting any biomass high in carbohydrates through a process similar to brewing beer. It is mostly used as a fuel additive to cut down a vehicle's carbon monoxide and other smog-causing emissions.

Energy Efficiency UK | American BioEnergy Association | methanol.org

Biobased Products

Renewable biodegradable products eg: green chemicals, renewable plastics & natural materials can replace many now derived from petrochemicals

Resources

Books on Bio-Fuels

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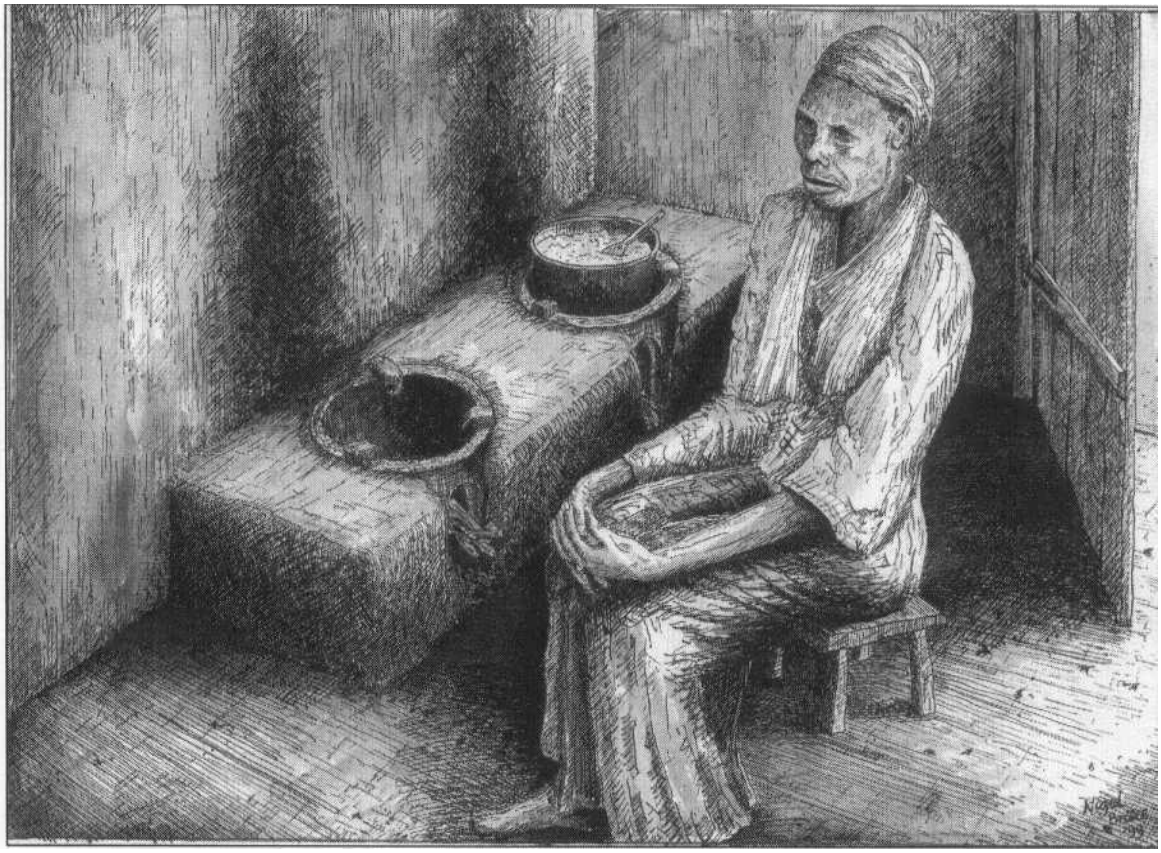

Reducing indoor air pollution in rural households in Kenya:

working with communities to find solutions

ITDG project 1998-2001

January 2002

PRACTICAL ANSWERS TO POVERTY

Reducing indoor air pollution in rural households in Kenya:

working with communities to find solutions

The ITDG Smoke and Health project
1998-2001

Dedicated to the memory of Peres Atieno Olumbo a member of the project team who died tragically young following a long illness

Project team

Kenya staff
Stephen Gitonga; Justin Nyaga; Hellen Owalla; Martha Mathenge; Milka Lang'at Edward Marona Peres Olumbo (deceased); Rose Okodo; Sharon Looremeta; Simon Ireri; Tony Katampoi Lemayian; Moses Mosiany; Vincent Okello; Amina Mateu; James Letiah; Michael Kathuri ; Joseph Gitahi, Charles Ganda and John Koite

UK staff
Alison Doig, Liz Bates

Project advisers
Dr Nigel Bruce; Dr. Jacob Kithinji

Project statisticians
Rosemary Nguti, Henry Mwambi

Funded by:
GlaxoSmithKline; Veta Bailey Charitable Trust; Ajahma Charitable Trust; Emerging Markets Charity

Cover; West Kenyan woman andUpesi stove
(iillustration: Nigel Bruce)

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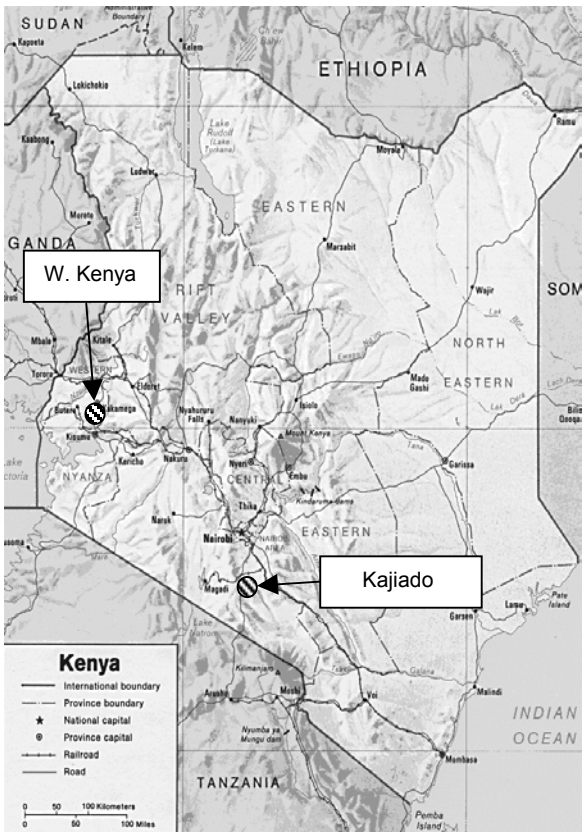
Executive summary



Around 80% of people in rural sub-Saharan Africa depend on biomass (wood, dung, crop residues) for domestic energy. There is mounting evidence that the resulting indoor air pollution (IAP) increases common, serious health problems, including childhood pneumonia and chronic lung disease. Previous attempts to reduce this have often failed due to lack of community involvement in developing appropriate, sustainable solutions.

The ITDG Smoke Project was launched on May 6,1998. The aim of the project was to contribute to the reduction of exposure to indoor air pollution in the light of these negative health effects. Working with 50 households in rural Kenyan communities, participatory technology development through participatory research methodologies enabled the project to alleviate this pollution in people's kitchens. Evaluation of changes in pollution levels and community views about the process and interventions was carried out.

Two study areas were chosen; Kajiado where ITDG is involved in the Maasai Housing Project and two communities in West Kenya where ITDG is engaged in the Stoves and Household Energy project. These two areas are totally different climatically and geographically as well as culturally (lifestyles, cooking habits and house types). Baseline monitoring in the kitchens in these areas showed that smoke levels were unacceptably high: in Kajiado, the 24-hour average of respirable particulates was 5526µg/m^3 and in West Kenya, the levels were 1713µg/m^3. If one compares these values to the EPA standards for acceptable annual levels of respirable particulates of 50µg/m3, it can be seen that the daily rates (which are comparable, in these societies to the annual rates) are over one hundred times greater in Kajiado and twenty times greater in West Kenya than the accepted values.

By involving communities in areas where ITDG is well-known and respected, participation and co-operation from people in monitoring the smoke levels of their houses was assured.

Main objectives

The main objectives of the project were twofold: to improve the quality of life, through reduction in indoor air pollution, for households in these study areas; and to develop a participatory methodology for further research into appropriate ways to alleviate indoor air pollution. These objectives were to be achieved through:

- Carrying out a baseline assessment of pollution and exposure, fuel use and house structure
- Identifying participatory ways of alleviating indoor air pollution through development and installation of interventions. (*Interventions*, within the context of this project, were identified as any changes which took place as a result of project activities which could affect the levels of indoor air pollution to which the occupants of the kitchen, especially women and children, were exposed.)
- Evaluation of changes in pollution and exposure, community views of the process used, and the acceptability and affordability of the interventions
- Empowerment of communities by making them aware of the risks associated with household smoke and enabling mechanisms for its alleviation
- Development of a strategy in a national context for dissemination and sustainability within the market constraints of the communities

- Exchanging experience internationally to strengthen Kenyan work and to contribute to implementation of best practice in other countries
- Development of a replicable participatory methodology on appropriate methods for reducing indoor air pollution. This methodology will form the basis for future work in international studies on indoor air pollution and interventions.

Key methods adopted in project

The participatory methods described in this publication, combined with technical monitoring, allowed the project to identify interventions that are both *appropriate* and *effective* in reducing indoor air pollution. Some key aspects include:

- The involvement of households throughout the project
- Finding out those factors associated with smoke which the community members themselves found most problematic
- Knowledge sharing on the dangers of smoke so that people in the community are empowered to take action
- Local teams being open to ideas and suggestions from the community on ways to modify interventions to benefit the households
- Installation of interventions in collaboration with the household members
- Monitoring, to find out which interventions were really effective in removing smoke
- Monitoring both the kitchen and the cook so that the inter-relationship between the levels in the kitchen and the levels she inhales can be assessed
- After interventions had been installed, learning the preferred options from the community.

Participatory development

Common themes and principles in participatory development (PTD) practice include:

- That the community is the main actor in any development initiative
- That the outsider's role is basically supportive to the local efforts
- That the development activities should be oriented towards needs as perceived by the community
- That indigenous knowledge has an important role to play as a basis for action, support and strengthening
- That the key challenge is to tap the potential interaction between indigenous knowledge and that of outsiders.

Activities

- Research study completed in 50 households in West Kenya and Kajiado.
- Awareness created in all selected households.
- Interventions installed in 50 houses in both West Kenya and Kajiado.
- Reduction in indoor air pollution levels – respirable particulates (PM_{resp}) and carbon monoxide (CO)
- Benefits of appropriate interventions discussed with households.
- Eight artisans trained on fabrication and installation of technical intervention in two regions.
- Women trained on operations and maintenance of the interventions.
- Focus group discussions held with the communities that promoted participatory interactive communications on health related issues of their families.
- Dissemination of knowledge through various media: publications, video, conferences

Key impacts

Reducing smoke

The primary concern of the project was to reduce indoor air pollution. There were substantial reductions in the particulate matter and carbon monoxide levels in the sample households after the interventions were installed. Table 0.1 gives the overall results – the statistical significance of these results will be detailed later in this report.

Table 0.1 Overview of reductions in particulates and carbon monoxide resulting from installation of interventions			
Reduction in particulates (%) – *(statistically significant results in bold)*			
	Kajiado	**West Kenya (4ft)**	**Combined**
All interventions	**36%**	**63%**	**43%**
Smoke hoods	**76%**	**70%**	**75%**
Eaves spaces		60% (average)	
Windows		**No observable change**	
Stoves	Not adopted	**54%**	
Reduction in room carbon monoxide (%)			
	Kajiado	**West Kenya (4ft)**	**Combined**
All interventions	**31%**	**53%**	**34%**
Smoke hoods	**77%**	74%	**78%**
Eaves spaces		28% (average)	
Windows		**No observable change**	
Stoves	Not adopted	42%	
Reduction in carbon monoxide inhaled by cook (%)			
	Kajiado	**West Kenya (4ft)**	**Combined**
All interventions	6%	32%	16%
Smoke hoods	28%	59%	35%
Eaves spaces	Not adopted widely	56% (average)	
Windows		**No observable change**	
Stoves	Not adopted	5%	

Poverty impacts

The project has seen the project households accrue socio-economic, health, and cost benefits as a result of project activities and interventions. Whilst maintaining cultural requirements of housing design, the project has made improvements in ventilation, natural lighting, maintenance and general comfort in these households.

- Substantial reductions in indoor air pollution will have a positive impact on the health of the community
- Provision of more time to engage in economic activities through using stoves, rather than three-stone fires
- Increased income through manufacture of smoke hoods, stoves, windows & frames for eaves spaces
- Savings realised through reduction in use of kerosene lamps and burning fuel more efficiently in stoves
- The community noted a reduction in time and money spent in hospitals with burns, coughs, eye, and chest pains
- Improved status of project women within community
- Women have gained confidence through the participatory activities
- Project team empowered with skills in data handling and analysis
- Reduction in fuel consumption through stove use with consequent reduction in pressures on biomass sources

Negative Impacts

- Houses are now cooler and experience more draughts due to openings in the houses – this is a negative impact during cold and wet weather
- Some cultural concerns about lack of privacy and security
- In West Kenya, where there was a cost-sharing element, this proved difficult for some households
- Difficulties with wick lamps when it is windy and the window is open

Chapter 1 – The relationship between health and household energy

Introduction

It is currently estimated that around two-thirds of all households in the developing countries still rely primarily on unprocessed biomass fuels (wood, dung, crop residues) for their daily cooking and heating needs (World Resources Institute 1998); this includes around 80% of all people in rural sub-Saharan Africa.

In many of these households, fuel is burned indoors on open fires or poorly functioning stoves, often with no means of ventilation or smoke extraction. As a consequence, very large numbers of women and young children are exposed to high levels of air pollution, every day of the year. Indeed, it has recently been argued that the greatest global burden of air pollution exposure occurs not outdoors in the cities of the developed world, but indoors in poor rural communities (WHO 1997).

Women and children are particularly vulnerable to kitchen smoke (photo: Nigel Bruce)

There is now consistent evidence that indoor air pollution (IAP) increases the risk of childhood acute respiratory infections, the most important cause of death of children under five years in least developed countries; and there is also association with birthweight, infant and perinatal mortality, pulmonary tuberculosis, some forms of cancer and cataract. Although the risks are poorly quantified, indoor air pollution may be responsible for nearly two million excess deaths in Least Developed Countries (LDCs), and around 4% of the global burden of disease (Bruce, Perez-Padilla, Albalak, 2000).

Table (1.1) shows typical values for particulate levels in the kitchen of a rural home, compared to current standards advised by the US Environmental Protection Agency (EPA).

Table 1.1: Pollution level (PM_{10}) in micrograms per cubic metre of air($\mu g/m^3$)

Source of exposure	During use	24 hour average	Annual average
Biofuel (wood, dung, etc)	Typically from 1000 up to 20 000 or more	Typically 500 to 1000 or more	24 hour average levels are experienced every day
US- EPA standard		Only 1% of 24 hour periods to exceed 150	50

Health problems related to household energy

Each aspect of household energy use has particular health problems associated with it, which can usefully be considered under the following three headings:

Fuel Use

It is difficult to isolate any one cause of illness when extreme poverty, manifested in malnutrition, poor housing etc. affects much of peoples' lives. Nevertheless, there are several serious illnesses for which indoor air pollution from biomass is a major factor.

Smoke consists of many gases and particles which are known to have serious effects on health. The two major, well-identified constituents which are known to cause damage are: *particulates* and carbon monoxide.

Respirable particulates (PM_{resp}) are the small particles of smoke, less than 10microns in size, which are inhaled and penetrate deep into the lungs. There is mounting evidence that particulates are a major risk factor for two serious illnesses:

- Acute respiratory infections (ARI) in infants
- Chronic obstructive lung disease (COLD) in adults - especially for the women doing the cooking

Carbon monoxide (CO) is responsible for poisoning (mainly from charcoal, and coal use); and lung cancer (from coal use).

There is mounting evidence that cooking with biomass substantially increases the risk of developing active tuberculosis (Mishra, Retherford, Smith 1997) and there is an increased risk of low birth weight. Eye problems are also frequently reported, but there is very little research evidence to date.

- Other direct effects include burns (open fires, kerosene), poisoning (e.g. from children drinking kerosene stored in soft drink bottles).
- There are also wider environmental health effects relating to the fuel efficiency of the fire/stove, and also to greenhouse gas production, which is a function of the completeness of combustion - this arises because a number of *products of incomplete combustion* (PICs) are quite potent greenhouse gases.

Fuel production

Production of biofuels can affect health in a variety of ways, especially through local environmental consequences:

- Land use (which also has economic implications, with indirect health effects)
- Erosion, and effects on water supply, etc.
- Energy, and natural resource use, for example associated with charcoal production

Fuel collection and supply

- The time taken to collect wood, especially as this becomes scarce, has an opportunity cost, mainly for women (but also children where they are involved) in terms of education, economic activity, child care, etc.
- Danger to women in current and past war zones, e.g. from land mines
- Physical effects of carrying large quantities of fuel wood, etc., again mainly involving women.

Despite considerable evidence for a link between smoke pollution from biomass fuels and a number of health problems, comparatively little research has been carried out to evaluate efforts in the household energy field to reduce this exposure. Given the high levels of exposure to smoke, and the very large numbers of women and children exposed in the world's poorest communities, substantial reductions in indoor air pollution from biofuels can be expected to have a tangible and important impact on public health. This project is seeking to identify appropriate ways to effect substantial reductions in indoor air pollution.

Chapter 2 – The ITDG smoke and health project

Project overview

The main objectives of the project were twofold: to improve the quality of life, through reduction in indoor air pollution, for households in these study areas; and to develop a participatory methodology for further research into appropriate ways to alleviate indoor air pollution. These objectives were to be achieved through:

- Carrying out a baseline assessment of pollution and exposure, fuel use and house structure
- Identifying participatory ways of alleviating indoor air pollution through development and installation of interventions. (*Interventions*, within the context of this project, were identified as any changes which took place as a result of the project which could affect the levels of indoor air pollution to which the occupants of the kitchen, especially women and children, were exposed.)
- Evaluation of changes in pollution and exposure, and community views of the process used, and the acceptability and affordability of the interventions.
- Empowerment of communities by making them aware of the risks associated with household smoke and enabling mechanisms for its alleviation
- Development of a strategy in a national context for dissemination and sustainability within the market constraints of the communities
- Exchanging experience internationally to strengthen Kenyan work and to contribute to implementation of best practice in other countries
- Development of a replicable participatory methodology on appropriate methods for reducing indoor air pollution. This methodology will form the basis for future work in international comparative studies on indoor air pollution and interventions.

Project locations

All the field work took place in Kenya (see Box 2.1) and was carried out in communities in two rural areas with whom ITDG has been working for several years:

- A Maasai community in the Kajiado region, located some 80km south of Nairobi
- West Kenya, in the Kisii and Luhya communities in Nyamira district (60 km SSE of Kisumu) and Mumias, 40km west of Kakamega.

Box 2.1: Facts about Kenya

Kenya remains one of the poorer East African countries, with a per capita GNP of US$360million (ranking it 170th in the world) and an average annual growth rate of 0.1%. The rural population (comprising 68% of the total) is largely dependent on biomass fuels for energy. With 46.4% of the rural population living below the poverty line, 47% without access to improved water supplies, and infant mortality standing at 124 per 1000births (cf. 115 in 1980), the country displays both a high level of poverty and poor health, and a relatively slow pace of development. (World Development Report 2000/2001 - figures for 1998-99)

Although ITDG is well-recognised in these two regions, the households which were involved in the study had not benefited directly from earlier projects, so the homes were on the whole very traditional and suffered from high levels of indoor air pollution.

Table 2.1 summarises information on the incidence, intensity and severity of poverty for food, overall or hard-core poverty lines in the project areas. The incidence of poverty is measured by the numbers in the total population living below the poverty line. Because the communities with whom ITDG is working are among the poorest groups in these regions, the figures given in Table 2.1 are likely to be conservative. These figures are based on 1994 surveys.

Table 2.1: Incidence of poverty in the project areas						
Type of poverty	**Food poverty**		**Overall poverty**		**Hard-core poverty**	
Area	%	Actual numbers	%	Actual numbers	%	Actual numbers
Kajiado	30	80 369	22	60 926	14	39 257
Nyamira	55	227 046	52	261 698	34	171 757
Kakamega	49	514 297	51	537 141	32	327 307

Source: Ministry of Planning and National Development, Poverty in Kenya – first report, June 1998

Low incomes and wages characterize both Kajiado and West Kenya. However for the Maasai community (one of the poorer communities in Kajiado), food availability, especially a balanced diet, is lacking. The Maasai traditionally rely on livestock products as a source of food. On the other hand, poor nutritional status in the West Kenya region is attributed to low family incomes. The way this income is distributed across the family is such that women (who are the household managers) do not necessarily have access to it.

The Kajiado region

The area of Kajiado is 21,105 km^2 with a projected population in 1999 of 450 118 (growth rate of 5.54%) based on the 1989 census results (Kajiado District Development Plan, 1997-2001).

Economic Factors

- Employment levels were expected to be only half that of the total population in 1997. Employment is mainly in pastoral and livestock activities, and to a lesser extent in agricultural activities, waged employment, mining and quarrying.
- Child labour is common for males aged 12-15 years who have to look after livestock.
- Female-headed households cannot inherit property unless they have a boy child. This is a potential cultural barrier to development.

Health and infant mortality

- The most common diseases in the district are malaria and respiratory diseases. Others are eye infections, worms, diarrhoea, skin diseases, generally due to scarcity of water and poor sanitation.
- Infant mortality is estimated at 90 per 1000 live births. The figure was drawn in 1997, only from those who sought help from medical facilities. The figure may have been higher because a large proportion of the population has no access to the medical facilities. Causes are malaria, measles, gastro-enteritis, acute respiratory infections, malnutrition, and polio.

ITDG's links with the community

The ITDG Maasai Housing Programme is community-based, working mainly with women's groups and individual women in a pastoral area in Kenya. Traditionally semi-nomadic, the Maasai have, over the years, adopted a more sedentary lifestyle. Whilst maintaining cultural requirements of housing design, the project has made improvements in ventilation, natural lighting, maintenance and general comfort.

In 1993, the Maasai Housing Project in Kajiado made a preliminary study of the exposure to carbon monoxide and respirable particulates in two Maasai households, which showed that the cooks were exposed to unacceptably high levels of both these (Young, 94). ITDG has thus been working in the region for a very long time, and this facilitated the in-house testing procedures, as the staff were trusted and made welcome.

Maasai houses

In Kajiado, problems with smoke alleviation interventions reflect both the extreme poverty and cultural barriers within the community; lack of finance; famine; dilapidated houses; cultural barriers (men do not like being looked at while they eat).

The Maasai households have lived for years in unventilated houses due to their pastoralist lifestyle. Now that the life has become more sedentary, the demand for durable housing is increasingly a burden for women. The height of the houses being monitored in Kajiado was mainly between 4.5 feet and 7 feet, with one or two falling outside this range. There are no windows but very small pigeonholes and hence poor lighting and ventilation and are usually so dark that tin lamps have to be lit during the day. Accidents happen, such as burns, snake and spider bites, loss of items, stepping on sharp objects, houses are infested with vermin and rodents , such as fleas, rats and bedbugs. The houses, including the roofs, are predominantly built of mud, which is plastered onto woven wooden stakes. Some roofs are made of ferro-cement.

Typical Maasai house in Kajiado region (*photo: Nigel Bruce)*

Cooking practices

Food is usually cooked during the day so that the cook can walk outside during cooking periods to get away from the smoke in the house. Cooking is done on a three stone fire, and when people go to sleep, most of them do not put out the fire but cover it with ash so that the fire smoulders till morning when the fire is rekindled again.

West Kenya

In Western Kenya, the Smoke project worked in Nyamira and Mumias-Butere districts with the Kisii and Luhya communities. The two areas are different topographically since Kisii is a highland zone while Mumias is in the middle zone.

Mumias is a sugarcane growing area with very little land for subsistence farming and with relatively low rainfall patterns. Sugar cane is the major cash crop. It is grown commercially and sold to Mumias Sugar Company. Women have very little land for subsistence farming because the land is for sugar cane production and the income goes to the men. Some women opt to weed some two to three rows of sugar cane and in between the rows, they are allowed to grow beans**.**

Nyamira, on the other hand, is a highland region and subsequently has higher rainfall. There is a lot of subsistence farming (maize, beans, bananas, vegetables, tomatoes) in addition to the cultivation of tea, and coffee as cash crops.

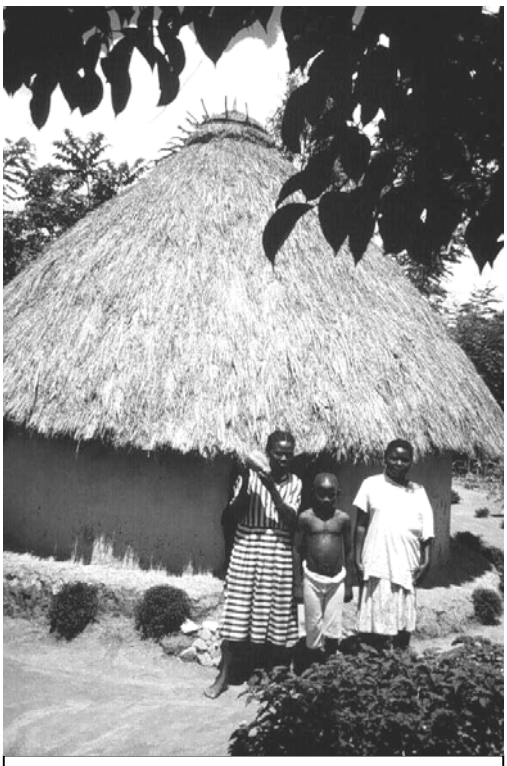
Nyamira, covers an area of 861 sq. km while Kakamega district covers an area of 2963 sq. km (Nyamira District Development Plan, 1994-1996; Kakamega District Development Plan, 1994 – 1996).

Health and infant mortality

- In West Kenya, the prevalent diseases are clinical malaria, upper respiratory tract infection, skin diseases, diarrhoea, intestinal worms and HIV/AIDS.

- By 1996, the infant mortality rate stood at 85 per 1000 live births. According to the KEPI (Kenya Extended Programme for Immunisation) survey carried out in 1992, the immunisation coverage for children under one year within the district was 72%.

ITDG has worked in West Kenya on household energy projects based on the production of the *Upesi* stove for over a decade. Initially focused on stove production, the project subsequently moved to providing a sustainable route through marketing and commercialization (Abbott, V. 2000). The smoke project is part of the current Stoves and Household Energy Programme, which also includes marketing and promotion training for stockists, retailers and promoters of stoves (Owala, 2001), ceramic stove production, and the production and distribution of training manuals on household energy. The work on smoke alleviation has benefited from the long-term relationship which ITDG has with communities in this area.



Kitchen in West Kenya: Note mud walls, thatch and absence of windows *(photo: ITDG)*

Housing

All the houses are built of mud; roofs are generally of thatch, although some are made of iron sheet. Houses in the two areas are characterised, as described below.

General household characteristics for Mumias

- Houses have racks on top of the fireplace, which may hinder erection of smoke hoods.
- The main fuel is firewood and crop residues.
- Kitchens are separate from the main houses.
- Kitchens have narrow eaves spaces of about 2 to 3 inches.
- Kitchens have small circular windows, hence the kitchen is poorly ventilated.
- Some houses used three- stone fires, mainly in homes where the Upesi project had not worked before. Many of the houses having improved cook stoves in the area owe the technology to the activities of the Upesi project.

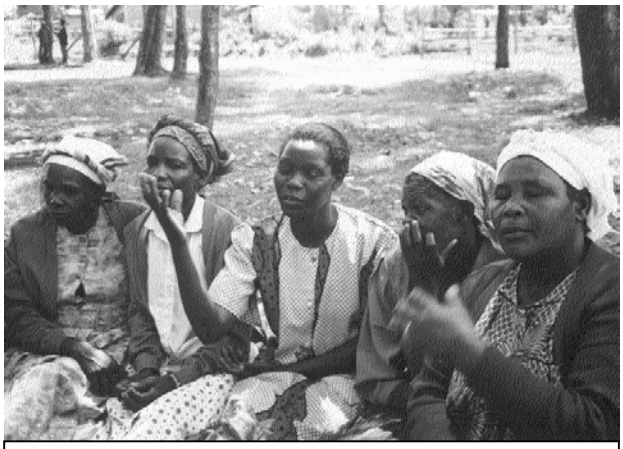
General household characteristics for Nyamira

- Kitchens separate from main house.
- No eaves spaces and, if present, they are blocked by the wood-rack (*Irongo*)
- Tiny windows and openings.
- In the period between the initial meeting with the women and the first pre-intervention monitoring, some people built upesi stoves in their kitchens

Chapter 3 – The participatory process

Community participation

Community participation has been a fundamental component of this project. This is built on ITDG experience over many years which shows that the people with whom the project works are best placed to express their own needs, and to identify potential solutions which suit their cultural, social and economic context. Indigenous knowledge has been highly valued throughout this work, and the community's (mostly women's) views and opinions have been listened to and addressed at all stages.



Women have gained in confidence through participatory activities *(photo: ITDG East Africa)*

During the Smoke project, participation has helped the communities to understand some of the problems they face as a result of smoke in their houses and also to be actively involved in formulating solutions. This chapter describes the participative methods used throughout the project. Participation has been on three levels:

- Community mobilisation and house selection
- Participatory Technology Development (PTD)
- Community participation in research

Community mobilisation

House selection incorporated the participative process, where women's groups were informed of the intentions of the project by the field staff, and helped in identifying houses based on the project's criteria. This ensured the community members' support throughout the project in terms of their time, being inconvenienced by the project equipment, adoption of new technologies, and other aspects of the project.

Participatory Technology Development (PTD)

PTD is the key development tool used throughout the project. It can be described as the collection of operational approaches, methods and techniques emphasising a high degree of user's participation in technology development; identification, implementation and development. It has its foundation on the premise that users are the best placed to decide which technologies they want to adopt, therefore greater participation may result in adoption of more appropriate technologies (ITDG Kenya Annual Report 1997).

All the smoke-alleviating technologies, developed in consultation with the cooks and their families, and all project stakeholders, therefore incorporate PTD elements. The technologies chosen must be acceptable, appropriate, durable, affordable and accessible to the local community.

Common themes and principles in PTD practice include an understanding of the following:

- That the community is the main actor in any development initiative
- That the outsider's role is basically supportive to the local efforts
- That the development activities should be oriented towards needs as perceived by the community
- That indigenous knowledge has an important role to play as a basis for action, support and strengthening
- That the key challenge is to tap the potential interaction between indigenous knowledge and that of outsiders.

Focus group meetings

Focus group meetings were held:

- To ensure that people's opinions and wishes were heard
- To sensitise the community to the risks of smoke, and enhance the households' awareness of the pre- and post-intervention benefits of the project interventions.

- To involve both men and women in participatory interactive communications on health related issues concerning their families.

The methodology included; brainstorming, discussions, examining case studies, interviews

Exchange visits

Exchange visits form an important part of local dissemination. They involve individual members of a community allowing others to visit their kitchens, in order to show off the interventions which have been installed. This happens naturally to a large extent within the community, but structured visits can also help to disseminate new ideas, as described in field reports (Box 3.1). Because it proved impossible to arrange visits between Kajiado and West Kenya, photographs were exchanged, to show each community what was happening in the other.

Box 3.1: Exchange visits

Exchange visits proved an effective way of disseminating information between community members. Initial reluctance on the part of many of the cooks turned to enthusiasm once they had seen the interventions in place in other people's kitchens.

- At the start of the project, only two of the women in Kajiado and none of the West Kenya women wanted smoke hoods installed. Once two had been installed in Kajiado, other women watched as the installation took place and observed how the smoke disappeared through the chimney. As a result, thirteen of the households opted for smoke hoods.

Constraints on community involvement

Although the women in the project areas were keen to be involved in every aspect of the project, various constraints limited their activities. The project staff had to avoid certain days e.g. market days (Wednesdays and Saturdays) and most meetings were held in the afternoon since the women were mostly committed in the morning hours to routine jobs such as fetching water, watering their animals. Distance was a major constraint for some of the women who had to trek several miles to get to the meeting venues. In West Kenya, some husbands were less supportive, unless their wives were 'paid' with flour, sugar etc. for the time spent.

Stakeholder involvement

Both local government ministries and locally-based organisations have been supportive and proactive throughout the project. This is essential in order to build the infrastructure necessary to make the successful interventions sustainable.

Women's groups

In mobilising and training the community, women's groups played a key role. During the project, women's groups usually co-ordinated activities and the meetings that were held with their members. The key informants were the group leaders (chair ladies) who served as a major link between the project facilitators and the community members.

Local government ministries

The project team enlisted the active support of the Ministry of Health, Ministry of Public Works and Housing, community development workers.

The African Medical and Research Foundation

The local Environmental Health Department of AMREF are involved in ongoing discussions with ITDG – East Africa on various collaborative ventures and support through their environmental health, sanitation and house improvement programmes to further this work.

The Maasai Technical Training Institute (MTTI)

The Maasai Technical Training Institute (MTTI) was engaged in the design, fabrication and procurement of the smoke hoods, and in artisanal training

The Jua Kali sector

The Jua Kali (informal manufacturing) sector has offered techniques that are affordable, sustainable and easy to adopt. Artisans have constructed all the hardware – hoods, frames for eaves spaces, windows.

Chapter 4 – Project activities

Project structure

The project was devised as a 'before-and-after' study, for which the key outputs would be substantial reductions in indoor air pollution and improvements in the quality of life for the beneficiaries. The opinions of the beneficiaries were recorded on the changes brought about by the interventions, whilst the air quality was monitored for reductions in particulates and carbon monoxide.

The project involved a multidisciplinary team, including fund raisers, project managers, scientific advisors, statisticians, field staff, enumerators, data entry/counter-check clerks, various partners (NGOs, government ministries, and research institutions), community artisans, and other community groups, as well as the individual householders themselves.

Although structured as a 'stand alone' project, the methodologies were closely aligned with those of earlier studies looking at the relationship between indoor air pollution and ill-health. The projected therefore benefited greatly from an adviser with direct experience in this related field.

Selection of households

The criteria for house selection were defined as follows:

- The most important criterion was willingness to participate in the project for its duration
- Preferably houses with children of 0 to 5 years. Mothers with children of this age tend to spend more time based in the kitchen and are therefore more vulnerable to smoke and the consequent respiratory problems
- A range of house types was chosen in West Kenya, from very traditional (often poor-quality) houses to houses which already had some improvements, such as *Upesi* stoves (see front cover) - this represented the living conditions experienced by the vast majority of people living in this region. The houses were identified and selected through the women's groups that ITDG had been working with since 1993 e.g. the Ichingo Women Group.
- In Kajiado, houses were selected that had not been improved by the Maasai Housing Project - again this represented the majority of homes. During house selection, the various women's groups were asked to identify houses that had not been improved under the Maasai Housing Project - the selection was done on ballot basis to avoid prejudices.

Training of enumerators

The field staff were trained as enumerators so that they could collect both numeric and descriptive data from each house. This involved training in: preparation of equipment, recording levels of smoke in each round, and recording household and house data.

Baseline survey

A baseline survey has two functions: to quantify the scale of the problem compared with international standards; to act as a baseline for any long-term changes brought about by interventions made during the project.

Data from the first two rounds of monitoring for particulates and carbon monoxide provided quantitative values for the levels of indoor air pollution in each of the households.

Questionnaires (see Annex 2) were used to identify key aspects of people's lives which might impact on indoor air pollution in their homes. These involved questions on households, housing, time budgets etc., a process which took about 20-45 minutes.

Focus-group discussions allowed the project team to discover the needs that the community identified as being most important to them. These discussions also allowed the team to find out the level of understanding within the community on the links between smoke and ill health.

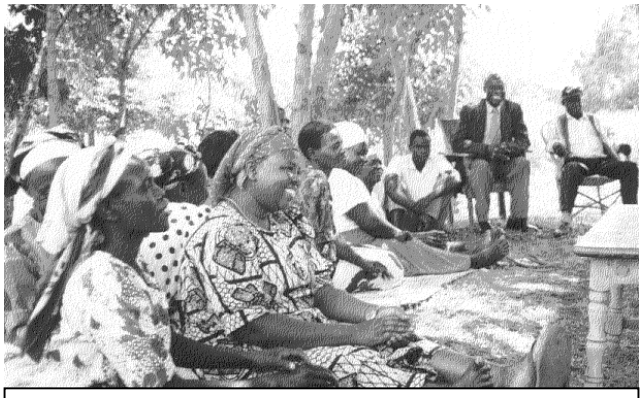
Visits to all the households allowed the team to discuss any traditional beliefs that needed to be considered when selecting interventions.

Discussions with all the households to decide on the interventions they needed.

Selection of interventions

A participatory approach was adopted right from the start, with individual and group discussions with the project families, especially the women, to identify possible smoke-alleviation methods which they would find acceptable, affordable and which were felt could be effective. This approach involved:

- Discussions on methods of smoke reduction, including improved stoves, windows, room height, smoke hoods etc.
- Exploring any locally available knowledge among community members on interventions
- Discussions on lighting and ventilation principles
- Involving women in selecting the locations of the interventions in the houses (windows, smoke hood/hoods)
- Discussing with the community members about the operation and maintenance of the interventions
- Discussing the efficiency of various interventions and the importance of opening windows and the realised benefits.
- Developing prototypes of the interventions e.g. windows, smoke hoods with the community
- Discussions on wood selection and method of drying and storage before the rains



Discussion groups were used to find out people's needs
(photo: ITDG East Africa)

The role of ITDG staff was to highlight the need for smoke interventions and to provide ideas and stimulate discussion on what might be done. The community members, in their turn, generated ideas based on their knowledge of the reality of their lives, identified constraints and ensured that the final decisions were realistic and in accordance with their wishes.

The information from these meetings was shared with the whole ITDG smoke team resulting in three possible types of intervention being identified: ventilation by enlarging the size of windows or opening eaves spaces; adding smoke hoods over the cooking area; and thirdly the option of installing improved cook stoves.

Although women in Kajiado believed (probably correctly) that those who had raised their roof height felt that indoor air pollution had been alleviated, the project team felt that this intervention was too costly to be reproduced by large numbers of people, so it was not adopted by the project.

The final design and materials used for the interventions was determined by the women themselves and availability of materials. In this way, local skills are used, the interventions are well accepted, and this should promote higher potential for future replication of the interventions in the area.

Quantitative measurement of indoor air pollution

Levels of indoor air pollution must be measured quantitatively, through smoke monitoring, and qualitatively, through interview and group discussion. This ensures that any interventions promoted in future work are effective as well as acceptable. For quantitative measurements, the levels of smoke must be measured both within the kitchen itself, and also the smoke inhaled by the person most affected - the woman of the house who does the cooking - described as 'the cook'.

Two key components of smoke were measured; respirable particulates (PM_{resp}) - less than 10microns diameter, and carbon monoxide (CO). The respirable particulates were measured using an air sampler, and carbon monoxide was measured using stain tubes.

Woman wearing CO monitor
(photo: Nigel Bruce)

Both respirable particulates and carbon monoxide were measured for each household over 24hours. However, since the monitoring was being conducted through the night as well as by day, it was important that the equipment used to measure the dose inhaled by the cook was as non-intrusive as possible. For this reason, the measured level of carbon monoxide she inhaled served as a proxy to assess the amount of particulates to which she had been exposed over this time. Statistical tests of association show a close correlation between CO and PM_{resp} in the kitchen, broadly in line with results reported by Naeher et al., hence it was felt appropriate to adopt this method for 24hour monitoring as the CO/ PM_{resp} relationship (Naeher LP, Smith KR, Leaderer BP, Neufeld L, Mage D, 2001). The stain tube used to record CO is silent, much smaller, and much less intrusive than a PM_{resp} monitor would be.

For each household, two rounds of monitoring were done before, and two rounds after, interventions had been installed in the houses. The two rounds were to reflect the wet and dry seasons and their effect on the levels of indoor air pollution in the kitchen.

Readings from the CO stain tubes were recorded by the field staff directly into the questionnaires. The particulates were collected on a filter paper which was dried and weighed using a six-point balance before and after monitoring to give the weight difference caused by the particulates. This procedure was organised by the project's scientific adviser at the University of Nairobi.

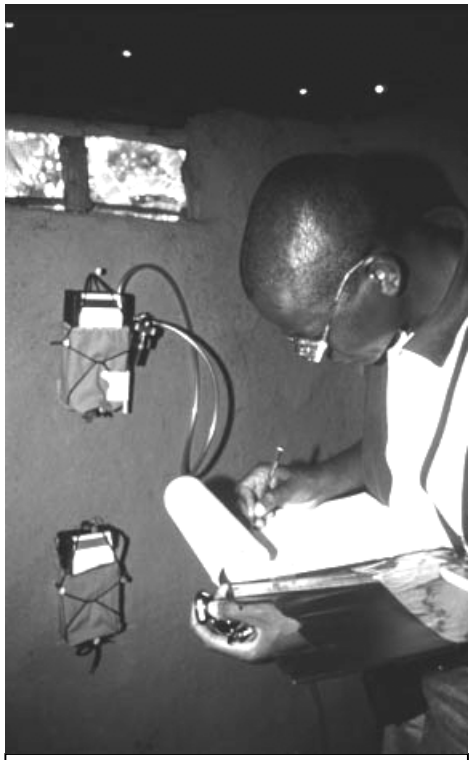
By comparing the levels of PM_{resp} and CO before and after particular interventions had been installed in a range of houses, it was possible to identify which interventions reduced indoor air pollution levels appreciably. A further step was to see the effect of the interventions on the indoor air pollution inhaled by the cook. The technical details involved in quantitative monitoring methods are detailed in Annex 1

Descriptive analysis and confounding variables

A series of questionnaires was devised (Annex 2), designed to be locally appropriate through discussions with members of the project team who were working in the field.

These questionnaires identified key aspects of people's lives which would be affected by their household energy use:

- A data collection sheet was used to record the levels of respirable particulates (PM_{resp}), levels of carbon monoxide in the room (CO) and personal carbon monoxide (PCO)for each household.
- A household questionnaire identified the size of the household, the way fuelwood was collected, the means



Member of field team recording PM level
(photo: Nigel Bruce)

of cooking, lighting, and other uses of energy.

- A house and kitchen questionnaire identified the type of house, the windows and other openings, the roof structure etc.
- Time/activity charts were used to determine when people were in the room whilst the fire was lit
- A basic health survey was done to identify the sort of problems which people were experiencing. Because of the low numbers in the study, this was not a baseline survey, but rather an overview of the health-related problems which the community identified.

Confounding variables are those aspects of people's lives (e.g. number of people to be cooked for), environmental factors (e.g. level of rainfall) which can influence the level of smoke pollution in the home and/or the level of personal exposure, and which are also associated with the interventions. The effects of these confounding factors needs to be considered if the actual impact of the interventions is to be correctly assessed. Changes in the most important confounding factors over the course of the project (in particular changes from the pre to post interventions periods) have therefore been reported, and the potential for confounding discussed. There is limited opportunity for formal statistical analysis of confounding due to the relatively small numbers in the study, but this will be carried out separately.

Focus group meetings

Pre-intervention meetings

Focus group meetings were held both before and after the interventions were installed. Pre-intervention discussions focused on which interventions were needed, the perceived causes of indoor air pollution, problems associated with indoor air pollution, and uses for smoke. The Smoke Project team gave a lead on some possible interventions that could be installed in the households such as enlarging the size of windows, eaves spaces, smoke hoods, installation of improved cook stoves. A sample of the outcome of these discussions is shown in Table 4.1.

Table 4.1 Pre-interventions discussions with women and men in West Kenya

Household number	Is smoke an issue?	Perceived causes	Problems	Smoke uses	Traditional beliefs	Possible changes?
HH 1	Yes	Lack of windows Door size Use of wet firewood Cooking for long hours Lack of other openings	Eye problems Cold	Chasing away insects Drying fuelwood Preserving cereals	None	Have windows Reposition the door Use bigger stoves
HH3	Yes	Position of the kitchen Size and position of window Lack of eave space Using wet fuelwood	Tearing of eyes and turning red Man avoids the kitchen Cold and flu	Was used for preserving cereals		
HH5	Yes	Size of openings Size of the kitchen	Colds and flu Coughs Tearing and red eyes	Insect repellent Drying fuel wood Preserving fuel	None	Build another kitchen Increase size of opening (window and eaves space)
HH6	Yes	Use of wet wood	Chest problem Breathing Cough	None	None	Build a new kitchen Is willing to work with the team on the changes required
HH8	Yes	Lack of eaves space Size of window Size of window	Tearing and red eyes Cough Flu	Dry fuelwood Preserving Cereals Insecticide	Smoke is a medicine for boils	Increase window size Increase eaves space Increase door size

Post-intervention West Kenya meetings
In the post-intervention period, they were used to understand the changes which had occurred in the communities over the duration of the project. Post-intervention discussions included training on how to use and maintain the interventions, suc as the need to open windows for them to be effective. The focus groups involved the stakeholder communities, mostly the participating women, and sometimes their husbands. They provided a forum for highlighting the effects and benefits of these activities.

Time-activity studies

Detailed time activity studies were undertaken for individual women and for groups in each area, in both wet and dry seasons. These studies reflect how changes in indoor air pollution level affect people's behaviour in their homes. The household questionnaires and the time activity studies combine to provide an overall picture of lifestyle among the Maasai and West Kenya communities. A typical day in the life of one of the Kajiado families is recorded as a time/activity record in Annex 3.

Installing interventions

There were four main types of interventions selected by the community members in Kajiado and West Kenya

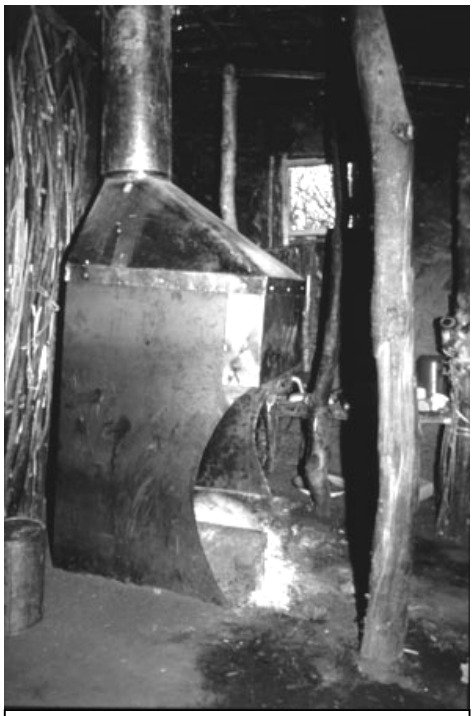
- Smoke hoods
- Eaves spaces
- Windows
- Improved stoves

Chapter 5 describes in detail the interventions that proved appropriate in each area.

Artisanal training

Kajiado

In Kajiado the Maasai Technical Training Institute in conjunction with the Ministry of Health undertook the training of artisans. The cooks were involved in material selection, sizing, shaping, positioning and production processes. The groups were able to show the desired positions of windows, vents, and the position of smoke hoods. They were shown pictures of different types of chimneys and smoke hoods from which to choose and were supplied with hard manila paper to design a model of the desired hood. The artisans transferred the design to the plates and sheets to cut out the parts and qualified artisans supervised production of the product. Pre-testing of the product with the households was crucial since changes were effected according to performance.



Smoke hood in Kajiado
(photo: Nigel Bruce)

West Kenya

An instructor from the Maasai Technical Training Institute trained two artisans and the Training Officer in the Kisumu YMCA. The training took eight days with all the five smoke hoods fabricated under his supervision. The hood designs were discussed in consultation with the households.

Follow-up activities

During this period, activities addressed sustainability at

local level:

- Operations and maintenance of the interventions
- Proper use of the interventions
- Personal and domestic hygiene
- Monitoring performance and effectiveness of interventions

The Ministry of Health, Culture and Social Services facilitated some of the meetings and exchange visits on domestic and personal hygiene, income generating project ideas, housing sanitation and operations and maintenance of the interventions.

Data analysis

Monitoring data was analysed to provide;

- A descriptive analysis of the baseline level of pollution in the study households, as well as the social, household, health and other factors which relate to the collection/supply and use of household energy in the home
- A description of the different types of intervention selected, their appearance (with photographs and sketches), the numbers of households adopting each intervention
- The change in ambient pollution levels in homes achieved through these interventions
- An assessment of the personal exposure for the woman (PCO) and time/activity assessments of women and young children

The results of the monitoring have been analysed statistically. Differences between the pre-intervention and post-intervention results reflect the impact of the project in terms of smoke alleviation. Annex 4 gives further details on the statistical methods adopted during the project.

Financial arrangements

The financial arrangements were different in each area. Kajiado suffers from severe poverty which was exacerbated, during the project period, by a drought which caused loss of livestock. Food aid was being sent by the government to the project families, and under these circumstances, it was agreed that there would be no costs incurred by the project families. Nevertheless, some provided assistance in installation of interventions, and some of the materials for building the interventions were purchased by the men in the community.

In West Kenya, there was a cost-sharing agreement from the start. Agreement was reached with the household owners of what each would contribute towards the cost of interventions.

Capacity building

Capacity building was addressed in several ways, and will form part of the ongoing smoke work:

Locally

- Involving other organisations throughout the project
- Training artisans
- Cost-sharing in West Kenya
- Dissemination through exchange visits, workshops, conferences, video

Internationally

- A new UK DfID-funded project 'Smoke, Health and Household Energy' started at the beginning of 2002. This project will build on the lessons learnt during this project to disseminate the methodologies in urban Kenya, Nepal and Sudan.
- Schemes to scale-up and commercialise the successful interventions within Kenya and the adjacent countries will form part of a further initiative through ITDG-East Africa and other key stakeholders.

Chapter 5 – Interventions

Table 5.1 outlines the selection made by each household. It can be seen that windows were popular in both areas, stoves and eaves spaces were favoured in West Kenya, whereas in Kajiado, smoke hoods were widely adopted.

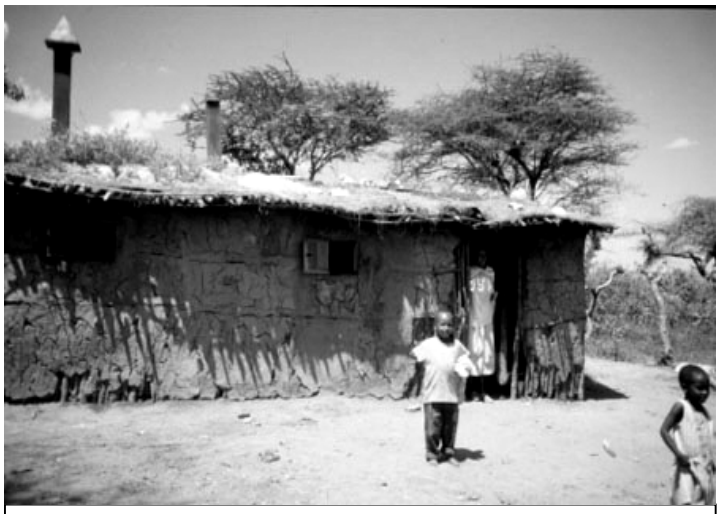
Table 5.1 Interventions installed in each household by end of project

	Window	Smoke hood	Upesi stove	Eaves spaces
West Kenya households	24	5	24	24
Kajiado households	24	12	0	2

**Some of these interventions were installed before project – see Chapter 6*

Smoke extraction through smoke hoods

A decision was made, in consultation with the community, to opt for smoke hoods rather than chimney stoves. This was based, in part, on two successful smoke hoods installed in Kajiado in the early 1990s and the failure of chimney stoves, several of which had been installed during a government scheme some years previously, and none of which had been used. In West Kenya there was little experience of either smoke hoods or chimneys. The figure opposite show the flue from the smoke hood and open window outside a house in Kajiado.

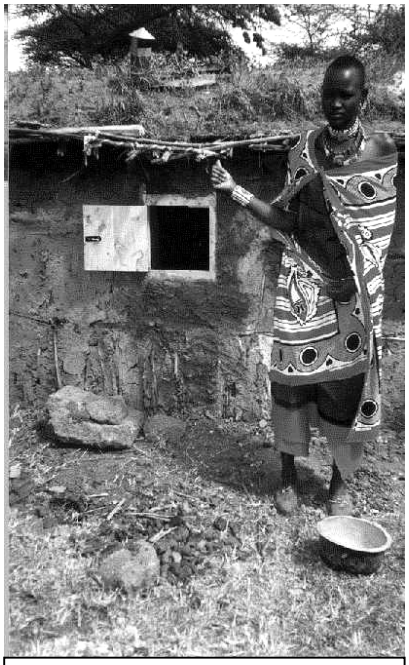


Maasai house showing open window and flue from smoke hood ***(photo: ITDG)***

Ventilation - through windows and eaves spaces

As shown in Chapter 2, the homes in Kajiado and West Kenya are entirely different constructions. However, in both areas, the rooms were largely unventilated, so windows and eaves spaces were adopted as possible interventions.

The windows were all of a standard size (0.3m x 0.3m), and cost approximately £10.40 to install, whilst the frame around the eaves space cost £4.35 (Exchange rate: 1UK£ ~ 115Ksh). The eaves spaces were cut into the wall at roof height and above the stove and a wooden frame inserted. They were made 150mm wide, and of varying length (long enough to vent the smoke as it reached roof height), typically 4-5m. Mesh was attached across the frame for added security, and to keep out rodents. Box 5.1 describes the participatory nature of the window installation.



Maasai woman showing newly installed window ***(photo: ITDG Kenya)***

Box 5.1:Case Study of Window installation

Process in HH40 (JK's house)
The installation exercise began in household 40 (JK's house) on 5th December. The team arrived in this boma at about 11.30 a.m. and asked the woman to suggest the window positions. JK. identified two locations which was a reflection of the husband's decision. The team however advised her that it would be better to have three windows instead of two to ensure through and cross ventilation. The size of the windows installed was 14 by 14 inches.

The exercise started at 12.00 noon and ended at 3.00 p.m. and it attracted women, men and children living in the same boma. The process created a lot of excitement as the house was opened up and some people sat inside to actually watch what was happening and they actively participated in passing their comments. After the first window was installed, JK (the owner of the house) really liked the idea of windows and decided she wanted four instead of three. However, the spectators were against the idea and said that this would infringe on her privacy since the house would be too open and the house would have less warmth which is characteristic of the Maasai houses. JK was actually lured to their idea and therefore the team only installed three windows in that house. JK later served the team with some tea (black tea since most of her cattle had died in the prolonged drought that the area had been experiencing).

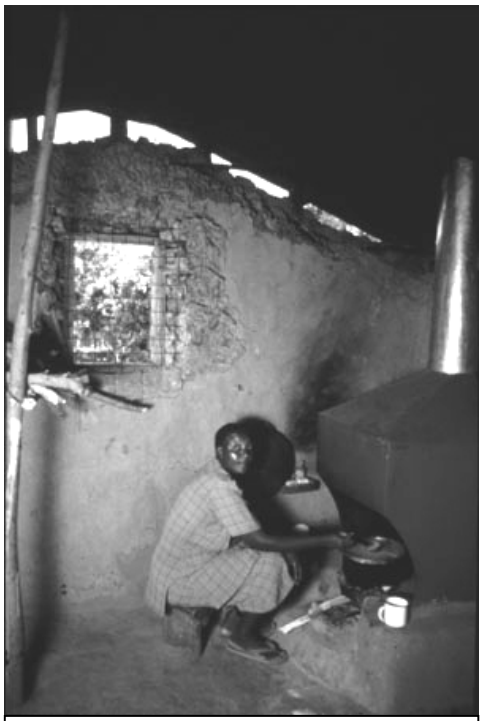
After witnessing the process in household 40, the husband of N. (household 41) was more than eager to have windows installed in his house the following day. In household 39, four windows were installed on 7th December.

Improved combustion through improved stoves

West Kenya has a good tradition of improved stove use where it is well-suited to the typical kitchens in the region. The Upesi stove, promoted through the household energy programmes, has been shown to reduce fuel use by about 40% *(Habermehl, 1994; Abbott, 2000) compared with three-stone fires. A key element in its success has been the training of the producers, sellers and promoters of the stoves (most of whom are local women), in effective dissemination techniques (Owala, 2001). This often involves demonstrations, and advice on the installation of the stoves. Many of the households with these improved stoves have reported marked improvements in the household environment, saying that:

- the kitchens are cleaner;
- the children's safety from domestic fires/accidents have been improved; and
- there is considerable saving in the use of fuel wood.

Upesi stoves cost approximately £1.20 for a single stove, and £2.40 for a double– to buy, and a £0.40-0.80 – to install.



West Kenya kitchen, showing upesi stove, smoke hood, eaves space and window ***(photo: ITDG East Africa)***

Interventions in Kajiado

The most popular intervention were windows, which everyone adopted, with about half the households opting for smoke hoods. None of the households adopted improved stoves and only two households requested eaves spaces. The eaves spaces were considered draughty, and also the house structure made it very difficult to cut eaves spaces at the top of the wall.

Interventions in West Kenya

As part of the participatory process with the household owners in the study, the West Kenya team selected a menu of activities to identify appropriate interventions:

- Visiting all the households to discuss the communities' perception of the indoor air pollution problems and the perceived causes of indoor air pollution. For most households, this discussion was held in the presence of the spouses.
- Exhibiting photographs of the interventions that had been completed in Kajiado evoked an enthusiastic response as described in field reports (Box 5.2)
- Revisiting the households to finalise decisions on the types of intervention and the method of installation.
- Reaching agreement with the household owners of what ITDG's contribution towards the interventions would be, and what would be met by the household.

Box 5.2: Technology transfer through photographs
Pictures of the Kajiado smoke hoods were shown to the households who were very excited to have the same in their houses. On brick smoke hoods, the Mumias community said it looked odd on the thatched roof and hence dropped the idea. Five smoke hoods were fixed in both Nyamira and Mumias with all the women very happy and excited. At one homestead, people danced with a lot of vigour to a traditional dance commonly known as "Mwana Abili Kayai" causing a stampede with a lot of ululation and thunder on the new technology.

The kitchen owners worked towards the improvements, identifying and negotiating with the artisans, and installing Upesi stoves in those houses where they had not previously been used.

Maintenance and use of interventions

- Discussions were held with households on the maintenance and use of each of these interventions – e.g. it was found that smoke hoods work better when there is a window directly opposite the fire, which improves combustion and when they are kept free from soot.
- It was found that during wet weather, families were closing all the windows – when cooking, the households are advised to keep some of the windows open to facilitate combustion and to minimise the pollutant concentration in the kitchen
- In West Kenya, the hood is made more durable by encasing the bottom of the hood in mud, and painting the hood to minimise rusting.

Chapter 6: Key findings affecting the communities in Kajiado and West Kenya

Descriptive analysis of households in Kajiado and West Kenya

Households

Table 6.1 looks at the number of occupants in each of the households in each area, before and after the interventions were installed. The large differences in children's ages reflect the fact that over a year had passed between pre- and post-intervention monitoring, age was not something which was considered important in the communities, and furthermore, the children often move between houses, especially in the Kajiado community. Adjusted meals reflect the smaller portions required by women and children, compared to those eaten by men (Stewart et al., 1987). It can be noted that there was no major change in the overall numbers of meals being cooked before and after the interventions were installed. Because of the famine in Kajiado, dried maize was included in the diet, which needed more cooking in the post-intervention period. Nevertheless, the questionnaires did not reflect any substantial change in the hard food / soft food ratio. (Hard foods included maize, beans etc. soft foods included tea, vegetables, milk, porridge)

The time spent cooking in Kajiado is considerably greater in the pre-intervention rounds. This reflects comments made by the women to the team that it is much easier to cook in kitchens where they can see what is happening clearly.

Table 6.1: Households – descriptive analysis

Characteristic		**Kajiado**				**West Kenya**			
		Pre-intervention		**Post - intervention**		**Pre-intervention**		**Post - intervention**	
	Level	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Age of woman - years	<19	1	5	0	0	0	0	0	0
	20-29	8	42	13	54	5	20	3	13
	30-39	7	37	5	21	7	28	6	25
	40-49	1	5	4	17	9	36	8	33
	50-59	2	11	2	8	4	16	5	21
	60+	0	0	0	0	0	0	2	8
1st child's age (median)		8		5		7.9		4.38	
2nd child's age (median)		4.5		5		4.3		3.5	
3rd child's age (median)		2.5		2		3.5		2.75	
Time spent in kitchen		2.5		1.52		3.8		3.14	
Pre/post reduction (%)		39.2				17.3			
Type of food – % per meal	Soft	79		74		97		93	
	Hard	21		26		0		06	
	Both	0		0		0.03		0.01	
Adjusted servings/household/meal*		3.88		4.18		4.68		4.94	

** Child meals = 0.5 x adult meals: Female = 0.8 x male meals (equal nos. of male/female assumed)*

Houses and kitchens

The data in Table 6.2 shows that wood is overwhelmingly the major fuel, with some use of biomass residues, especially in West Kenya. Kerosene is mainly used for lighting (using wick lamps) although a few households use it for secondary fuel for cooking. It would appear that fuel is not routinely dried. Whilst fuel is scarce, there was no significant change in its availability before and after the installation of interventions – scarcity was reported at around 20-25% in Kajiado, and 60-70% in West Kenya.

Table 6.2: Houses and kitchens – descriptive analysis

		Kajiado				West Kenya			
		Pre-intervention (n=19)		*Post-intervention (n=24)*		*Pre-intervention (n=25)*		*Post-intervention (n=24)*	
Characteristic	**Level**	***n***	***(%)***	***n***	***(%)***	***n***	***(%)***	***n***	***(%)***
Main Fuel	Wood	19	100	23	96	25	100	24	100
	Residues & dung	0	0	1	4	0	0	0	0
Secondary fuel	Wood	0	0	0	0	0	0	0	0
	Residues & dung	2	10	3	12.5	13	52	9	38
	Charcoal	0	0	3	12.5	1	4	1	4
	Kerosene	0	0	0	0	1	4	2	8
Drying fuel	Usually	0	0	1	4	19	76	17	71
	Sometimes	4	21	4	17	6	24	6	25
	Never	15	79	19	79	0	0	1	4
Adequacy of fuel	Very adequate	11	58	10	42	4	16	3	12
	Just adequate	4	21	8	33	2	8	6	25
	Rather scarce	2	10.5	6	25	10	40	10	42
	Very scarce	2	10.5	0	0	9	36	5	21

Interventions

The results in Table 6.3 reflected the interventions that had been installed in the kitchens of the communities in Kajiado and West Kenya during the study–the vast majority of these changes were as a result of the project.

Table 6.3: Houses and kitchens – Interventions installed

		Kajiado				West Kenya			
		Pre-intervention (n=19)		*Post-intervention (n=24)*		*Pre-intervention (n=25)*		*Post-intervention (n=24)*	
Characteristic	**Level**	***n***	***(%)***	***n***	***(%)***	***n***	***(%)***	***n***	***(%)***
Smoke extraction	None	19	100	11	46	25	100	19	80
	Hoods/chimneys	0	0	12	50	0	0	5	20
	Missing data	0	0	1	4	0	0	0	0
Eaves	None	19	100	22	92	9	36	0	0
	Medium	0	0	2	8	13	52	9	38
	Large	0	0	0	0	3	12	15	62
Stove	Improved	0	0	0	0	10	40	21	88
	Traditional	19	100	24	100	15	60	1	4
	Other or missing					0	0	2	8
Primary window	No window	0	0	0	0	7	28	0	0
	25mm-149mm	16	84	0	0	1	4	1	4
	150mm-600m	3	16	24	100	12	48	14	58
	>0.6m	0	0	0	0	7	28	9	38
Second window*	25mm-149mm	16	84	0	0	0	0	1	4
	150mm-0.6m	3	16	24	100	9	36	12	50
	>0.6m	0	0	0	0	1	4	11	46
	No window	0	0	0	0	15	60	0	0

**The increase in size is for the two largest windows. In Kajiado, several of the houses had three or four installed in total*.

Women's health

This project was designed to look at the smoke-alleviating effects of installing interventions; it did not attempt to measure the health effects directly. Nevertheless, the pollution indicators recorded reflect the likely health impact of kitchen smoke on the cook and her children. Table 6.4 is a summary of the health problems reported by the cooks in the questionnaires, and is intended to give an overview of the smoke-related health problems experienced in each community. It is based on standard questions from the Medical Research Council for respiratory disease. Because of the limited numbers involved, it was statistically inappropriate to look at the before/after effects of interventions on health. Table 6.4 therefore gives a compiled number of reported ailments for each community, combining all pre- and post-intervention data.

Table 6.4 Health problems identified by the cooks

		Kajiado		**Kisumu**	
		No. of records	**% with problem**	No. of records	**% with problem**
Cough	i)First thing in the morning	74	**24.32**	97	**16.49**
	ii)During day (or at night in wettest coldest season)	65	**27.69**	76	**21.05**
	If 'yes' to i) or ii), cough most days for up to 3 months a year	23	**26.09**	26	**26.92**
Phlegm	i)From chest in the morning during cold/wet season	73	**20.55**	102	**20.59**
	ii)During day (or at night in wettest coldest season)	70	**21.43**	87	**21.84**
	If 'yes' to i) or ii), phlegm most days for up to 3 months a year	17	**5.88**	44	**13.64**
Cough & phlegm	In last three years, cough and phlegm together lasting 3 weeks or more	73	**13.70**	98	**18.37**
Wheezing	Wheezing or whistling in chest in last 12 months	74	**13.51**	79	**24.05**
	Woken up last 12mths at night with shortness of breath	73	**10.96**	90	**27.78**
Chest illness	During past 3 years preventing usual activities for as much as a week	74	**17.57**	78	**28.21**
TB	Ever been told by a doctor that suffering from tuberculosis	74	**0.00**	98	**4.08**
Eyes	Red, watering eyes sometimes or much of time	47	**55.32**	67	**17.91**
	Sore, sometimes or much of time	47	**27.66**	66	**13.64**
	Swollen, sometimes or much of time	47	**12.77**	66	**10.61**
	Affected by light, sometimes or much of time	47	**61.70**	64	**20.31**
	Vision impaired, sometimes or much of time	47	**29.79**	67	**38.81**

Quantitative results on changes in indoor air pollution

Overall pollution levels

The pre-intervention levels of PM_{resp} in Kajiado were over 5000$\mu g/m^3$ and in West Kenya were over1700$\mu g/m^3$. Kitchen CO levels were 74ppm in Kajiado and over 10ppm in West Kenya and personal CO (COwm) was about 7ppm and 4ppm in Kajiado and West Kenya respectively. It should be noted that the personal measures do not give any indicator of the peak levels either in the room or experienced by the woman.

Overall changes in 24-hour averages following the interventions in Kajiado showed a 36 % reduction in PM_{resp}, and in West Kenya there was an overall reduction of over 60%. Significant substantial reductions were observed in both Kajiado and West Kenya for particulates and room CO. There were reductions in personal PCO but these reached only a marginal level of signficance (p=0.06Wilcoxon).

For West Kenya, mean levels are consistently lower (30-45% reduction) for monitoring at 2.5ft compared to 4ft. The results in both pre- and post-intervention rounds show this characteristic. This emphasises the need for consistency in measurement, and the problems of comparing results with data from other projects.

Table 6.5: Changes in 24hour respirable particulates – all interventions

		Kajiado (all 4ft)			West Kenya (see height)		
	Height (ft)	*N*	*Mean*	*(SE)*	*N*	*Mean*	*(SE)*
Pre-intervention mean	4	23	5526.7	534.2	23	1713.6	260.9
Post-intervention mean		23	3522.4	510.6	23	628.9	70.2
Difference (pre/post)		23	2004.3	850.6	23	1084.7	261.1
p-value: Wilcoxon			0.048			0.000	
p-value: T-test			0.028			0.000	
Pre-intervention mean	2.5				23	993.0	176.6
Post-intervention mean					23	421.9	51.6
Difference (pre/post) (95% CI)					23	571.1	186.4
p-value: Wilcoxon						0.003	
p-value: T-test						0.006	

	Kajiado and West Kenya combined – 4ft		
	N	*Mean*	*(SE)*
Pre-intervention mean	46	3620.15	408.78
Post-intervention mean	46	2075.63	333.84
Difference (pre/post) (95% CI)	46	1544.52	445.24
p-value: Wilcoxon		<0.001	
p-value: T-test		0.001	

Table 6.6: Changes in 24hr room carbon monoxide – all interventions							
		Kajiado (all 4ft)			West Kenya (see height)		
	Height (ft)	*N*	*Mean*	*(SE)*	*N*	*Mean*	*(SE)*
Pre-intervention mean	4	23	74.66	5.89	23	10.08	2.12
Post-intervention mean		23	51.37	8.10	23	4.69	0.45
Difference (pre/post) (95% CI)		23	23.28	8.92	23	5.39	2.21
p-value: Wilcoxon			0.010			0.018	
p-value: T-test			0.016			0.023	
Pre-intervention mean	2.5				23	6.67	1.26
Post-intervention mean					23	3.64	0.37
Difference (pre/post) (95% CI)					23	3.03	0.41
p-value: Wilcoxon						0.043	
p-value: T-test						0.085	

	Kajiado and West Kenya combined – 4ft		
	N	*Mean*	*(SD)*
Pre-intervention mean	46	42.37	5.72
Post-intervention mean	46	28.03	5.31
Difference (pre/post) (95% CI)	46	14.34	4.74
p-value: Wilcoxon		0.004	
p-value: T-test		0.001	

Table 6.7: Changes in 24 hour personal carbon monoxide – all interventions						
Time	**Kajiado**			**West Kenya**		
	N	***Mean***	***(SE)***	***N***	***Mean***	***(SE)***
Pre-intervention mean	23	6.98	0.75	24	4.16	0.97
Post-intervention mean	23	6.54	1.14	24	2.83	0.46
Difference (pre/post) (95% CI)	23	0.44	1.14	24	1.34	0.97
p-value: Wilcoxon		0.229			0.194	
p-value: T-test		0.704			0.183	

PCO	Kajiado and W. Kenya combined		
	N	*Mean*	*(SE)*
Pre-intervention mean	47	5.54	0.64
Post-intervention mean	47	4.65	0.66
Difference (pre/post) (95% CI)	47	0.90	0.74
p-value: Wilcoxon		0.060	
p-value: T-test		0.233	

Changes in pollution associated with specific interventions

Effect of hoods
Prior to the study, no smoke extraction hoods or chimneys had been installed in any of the study kitchens. During the project, twelve were installed in Kajiado, and five were installed in West Kenya.

A comparison of homes that received hoods with those that did not, showed substantial ly greater reductions in respirable particulates in both Kajiado and West Kenya respirable particulates as a result of this intervention; marked reductions were also seen for kitchen CO and PCO.

Table 6.8: Changes in 24hr respirable particulates: Effect of hoods					
Kajiado					
Time		**Hoods (n=10)**		**Other interventions (n=13)**	
		mean	***(SE)***	***mean***	***(SD)***
Pre-intervention		5991.2	1122.1	5169.4	4178.0
Post intervention		1439.1	322.4	5124.9	541.7
Difference (pre/post)		4552.1	1321.1	45.5	777.2
p-value:Wilcoxon		0.007		0.81	
p-value: T-test		0.007		0.96	
Difference in pre- intervention values		509.5	1031.2		
p-value:Mann Whitney		0.6300			
p-value: T-test		0.90			
Difference in post intervention values		3764.5	652.5		
p-value: Mann Whitney		<0.001			
p-value: T-test		<0.001			
West Kenya (note only 5 with hoods)					
Time	Height (ft)	**Hoods (n=5)**		**Other interventions (n=18)**	
		mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	4ft	1167.6	434.9	1865.2	305.8
Post-intervention		345.9	87.7	707.5	77.3
Difference (pre/post)		821.7	449.9	1157.8	313.1
p-value: Wilcoxon		0.14		0.002	
p-value: T-test		0.14		0.001	
Difference in pre- intervention values		647.8	617.9		
p-value:Mann Whitney		0.21			
p-value: T-test		0.49			
Difference in post intervention values		458.5	244.4		
p-value: Mann Whitney		0.01			
p-value: T-test		0.25			
Pre-intervention	2.5ft	1158.1	392.1	947.2	202.4
Post intervention		208.5	30.7	481.2	58.2
Difference (pre/post)		950.0	396.4	466.0	210.2
p-value: Wilcoxon		0.08		0.74	
p-value: T-test		0.08		0.04	
Difference in pre- intervention values		192.9	419.1		
p-value:Mann Whitney		0.79			
p-value: T-test		0.65			
Difference in post intervention values		320.34	145.05		
p-value: Mann Whitney		0.002			
p-value: T-test		0.04			

Table 6.8: Changes in 24hr respirable particulates: Effect of hoods (contd) Kajiado and West Kenya combined				
Time	**Hoods (n=15)**		**Other interventions (n=31)**	
	mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	4383.3	962.8	3250.9	385.6
Post intervention	1074.7	253.5	2560.0	457.8
Difference (pre/post)	3308.6	994.0	690.9	379.0
p-value:Wilcoxon	0.001		0.03	
p-value: T-test	0.005		0.08	
Difference in pre- intervention values	836.6	876.7		
p-value:Mann Whitney	0.69			
p-value: T-test	0.35			
Difference in post intervention values	1516.3	503.7		
p-value: Mann Whitney	0.020			
p-value: T-test	0.004			

Table 6.9: Changes in 24hour kitchen carbon monoxide: effect of hoods					
Kajiado					
Time		**Hoods (n=10)**		**Other interventions (n=13)**	
		Mean	***(SE)***	***mean***	***(SE)***
Pre-intervention		67.81	10.16	79.92	6.90
Post intervention		15.05	5.00	79.31	6.99
Difference (pre/post)		52.76	11.57	0.61	9.09
p-value: Wilcoxon		0.005		0.83	
p-value: T-test		0.001		0.95	
Difference in pre- intervention values		8.42	12.85		
p-value:Mann Whitney		0.24			
p-value: T-test		0.52			
Difference in post intervention values		65.21	8.72		
p-value: Mann Whitney		<0.001			
p-value: T-test		<0.001			
West Kenya – note only 5 with hoods					
Time	Height (ft)	**Hoods (n=5)**		**Other interventions (n=18)**	
		Mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	4ft	7.79	3.17	10.72	2.58
Post-intervention		2.00	0.69	5.44	0.39
Difference (pre/post)		5.79	3.28	5.28	2.72
p-value: Wilcoxon		0.08		0.10	
p-value: T-test		0.15		0.07	
Difference in pre- intervention values		2.93	5.07		
p-value:Mann Whitney		0.41			
p-value: T-test		0.57			
Difference in post intervention values		3.79	1.05		
p-value: Mann Whitney		0.002			
p-value: T-test		0.002			
Pre-intervention	2.5ft	7.69	5.43	6.39	6.3
Post intervention		1.75	0.92	4.17	1.58
Difference (pre/post)		5.94	5.73	2.22	6.94
p-value: Wilcoxon		0.04		0.57	
p-value: T-test		0.08		0.19	
Difference in pre- intervention values		0.90	3.00		
p-value:Mann Whitney		0.41			
p-value: T-test		0.77			
Difference in post intervention values		2.48	0.73		
p-value: Mann Whitney		0.004			
p-value: T-test		0.003			
Kajiado and West Kenya combined					
Time		**Hoods (n=15)**		**Other interventions (n=31)**	
		mean	***(SE)***	***mean***	***(SE)***
Pre-intervention		47.81	10.12	39.79	7.00
Post intervention		10.70	3.67	40.36	7.25
Difference (pre/post)		37.10	9.66	22.55	4.05
p-value: Wilcoxon		0.001		0.26	
p-value: T-test		0.002		0.42	
Difference in pre- intervention values		6.15	12.16		
p-value:Mann Whitney		0.73			
p-value: T-test		0.61			
Difference in post intervention values		25.33	7.86		
p-value: Mann Whitney		0.007			
p-value: T-test		0.002			

Table 6.10: Changes in 24hour personal carbon monoxide: Effect of hoods				
Kajiado				
Time	**Hoods (n=10)**		**Other interventions (n=13)**	
	mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	6.92	0.73	7.04	1.22
Post intervention	4.93	1.73	7.79	1.47
Difference (pre/post)	1.99	1.39	-0.75	1.69
p-value: Wilcoxon	0.07			
p-value: T-test	0.19			
Difference in pre- intervention values	0.520	1.40		
p-value:Mann Whitney	0.22			
p-value: T-test	0.72			
Difference in post intervention values	3.10	2.16		
p-value: Mann Whitney	0.009			
p-value: T-test	0.17			
West Kenya – note only 5 with hoods				
Time	**Hoods (n=5)**		**Other interventions (n=18)**	
	mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	3.30	0.92	4.43	1.27
Post-intervention	1.33	0.27	3.11	0.56
Difference (pre/post)	1.97	0.96	1.32	1.28
p-value: Wilcoxon	0.043		0.65	
p-value: T-test	0.100		0.32	
Difference in pre- intervention values	1.46	2.47		
p-value:Mann Whitney	0.62			
p-value: T-test	0.56			
Difference in post intervention values	1.88	1.08		
p-value: Mann Whitney	0.003			
p-value: T-test	0.10			
Kajiado and West Kenya combined				
Time	**Hoods (n=15)**		**Other interventions (n=31)**	
	Mean	***(SE)***	***mean***	***(SE)***
Pre-intervention	5.71	0.72	5.52	0.92
Post intervention	3.73	1.22	5.07	0.80
Difference (pre/post)	1.98	0.95	0.45	1.02
p-value: Wilcoxon	0.01		0.91	
p-value: T-test	0.06		0.66	
Difference in pre- intervention values	0.20	1.32		
p-value:Mann Whitney	0.28			
p-value: T-test	0.88			
Difference in post intervention values	1.44	1.36		
p-value: Mann Whitney	0.018			
p-value: T-test	0.30			

Effect of eaves spaces

In Kajiado, eaves spaces were adopted by only two households, whereas in West Kenya, where the structure of the houses is more conducive to the enlargement of the eaves, every house decided to adopt this intervention to some extent. Eaves spaces provided substantial benefits in West Kenya, reducing respirable particulates by about 60% where the eaves spaces increased from 'small' to large', and to a lesser extent where moderate eaves spaces were enlarged. An interesting aspect of this intervention is that it was very successful in eliminating all the very high levels of particulates. This can be observed in the marked reduction in standard error, which is a measure of the scatter of the data. This is most evident at the 4ft level, where the smoke is nearer the eaves spaces and further away from the fire.

Table 6.11 Change in 24hour respirable particulates – effect of eaves spaces				
	Eaves spaces – 4ft		Eaves spaces – 2.5ft	
	mean	*(SE)*	*mean*	*(SE)*
Small to large eaves (n=8)				
Pre-intervention	2042.80	331.41	821.35	111.90
Post-intervention	766.70	105.70	464.65	96.66
Difference (pre/post)	1276.10	287.61	356.69	78.65
p-value: Wilcoxon	0.012		0.012	
p-value: T-test	0.003		0.003	
Moderate to large eaves (n=3)				
Pre-intervention	962.97	373.83	514.19	220.19
Post-intervention	469.87	115.55	407.50	128.67
Difference (pre/post)	493.11	258.42	106.69	330.18
p-value: Wilcoxon	0.11		0.59	
p-value: T-test	0.20		0.78	

Table 6.12: 24 hour kitchen carbon monoxide – effect of eaves spaces				
	Eaves spaces – 4ft		Eaves spaces – 2.5ft	
	Mean	*(SE)*	*mean*	*(SE)*
Small to large eaves n=8				
Pre-intervention	8.54	1.33	5.18	0.80
Post-intervention	5.65	0.50	4.32	0.52
Difference (pre/post)	2.89	1.44	0.86	1.00
p-value: Wilcoxon	0.092		0.482	
p-value: T-test	0.084		0.42	
Moderate to large eaves (n=3)				
Pre-intervention	4.93	1.59	3.19	0.14
Post-intervention	4.86	0.42	4.03	0.69
Difference (pre/post)	0.07	2.00	0.83	0.64
p-value: Wilcoxon	1.00		0.18	
p-value: T-test	0.975		0.321	

Table 6.13: 24 hour personal carbon monoxide – effect of eaves spaces		
	Mean	*(SE)*
Small to large eaves n=8		
Pre-intervention	4.08	1.07
Post-intervention	3.62	1.21
Difference (pre/post)	0.46	0.43
p-value: Wilcoxon	0.26	
p-value: T-test	0.32	
Moderate to large eaves (n=3)		
Pre-intervention	9.57	7.30
Post-intervention	2.36	0.27
Difference (pre/post)	7.21	7.54
p-value: Wilcoxon	1.00	
p-value: T-test	0.44	

Effect of stoves

In Kajiado, it was evident to the team that the cooks in this region wished to continue using the traditional three-stone fire, and there was no desire for change to a fuel-efficient stove. In West Kenya, although data from the houses receiving stoves during the project indicates a reduction in all variables, a similar difference is observed for those houses which have had stoves from the start of the project. This suggests that the effect is due to the eaves rather than the stoves, since all of these houses had some enlargement of eaves spaces. Further analysis of these inter-related effects is not being carried out due to the relatively small numbers. Only West Kenya houses without hoods were included in this analysis.

Table 6.14: 24 hour respirable particulates – effect of stoves

Height = 4ft				
Time	**Stoves installed during project N=8**		**Stoves throughout N=10**	
	Mean	***(SD)***	***mean***	***(SD)***
Pre-intervention	1929	1347	1814	1327
Post-intervention	874	345	574	258
Difference (pre/post) and 95% CI	1055	1543	1239	1209
p-value: Wilcoxon	0.07		0.005	
p-value: T-test	0.09		0.01	
Difference in post intervention values				
p-value:Wilcoxon				
p-value: T-test				
Height = 2.5ft				
Time	**Stoves installed during project N=7**		**Stoves throughout N=10**	
	Mean	***(SD)***	***mean***	***(SD)***
Pre-intervention	971	759	979	990
Post-intervention	446	247	485	262
Difference (pre/post) and 95% CI	524	920	494	938.81
p-value: Wilcoxon	0.87		0.51	
p-value: T-test	0.18		0.13	
Difference in post intervention values				
p-value:Wilcoxon				
p-value: T-test				

Table 6.15: 24 hour kitchen carbon monoxide – effect of stoves				
Height = 4ft				
Time	**Stoves installed during project N=8**		**Stoves throughout N=10**	
	Mean	***(SD)***	***mean***	***(SD)***
Pre-intervention	10.63	10.22	10.79	12.05
Post-intervention	6.09	2.02	4.92	1.09
Difference (pre/post) and 95% CI	4.53	11.99	5.88	11.75
p-value: Wilcoxon	0.73		0.07	
p-value: T-test	0.67		0.15	
Difference in post intervention values				
p-value:Wilcoxon				
p-value: T-test				
Height = 2.5ft				
Time	**Stoves installed during project N=7**		**Stoves throughout N=10**	
	Mean	***(SD)***	***mean***	***(SD)***
Pre-intervention	6.67	5.82	6.62	7.08
Post-intervention	3.93	1.8	4.13	1.42
Difference (pre/post) and 95% CI	2.74	7.21	2.5	7.17
p-value: Wilcoxon	1.0		0.05	
p-value: T-test	0.55		0.13	
Difference in post intervention values				
p-value:Wilcoxon				
p-value: T-test				

Table 6.16: 24 hour personal carbon monoxide – effect of stoves				
Time	**Stoves installed during project N=8**		**Stoves throughout N=10**	
	Mean	***(SD)***	***mean***	***(SD)***
Pre-intervention	2.89	0.97	5.67	7.09
Post-intervention	2.72	1.24	3.42	3.06
Difference (pre/post) and 95% CI	0.17	1.65	2.25	7.14
p-value: Wilcoxon	0.62		0.75	
p-value: T-test	0.78		0.35	
Difference in post intervention values				
p-value:Wilcoxon				
p-value: T-test				

Effect of windows

In Kajiado, although the majority of the houses had windows, most of them were very small. In West Kenya, seven had no windows, but there was an external door. All houses had their windows enlarged, and where appropriate they were repositioned. A separate analysis showed that windows had no effect in West Kenya can be observed in Kajiado – (see Tables 6.8 and 6.9 pre- and post- results for no hoods). It would appear that the reduction of IAP in the houses without hoods is largely due to eaves spaces.

Social impacts of interventions

For an intervention to be successful, it must be acceptable to the cook if it is to lead to greater adoption rates in the region – the first stage in scaling up. The observations made by the community, both structured and unsolicited, were recorded by the staff in field notes from focus group discussions and individual interviews.

Poverty alleviation

The project has alleviated poverty in the project homes both directly and indirectly. This has been achieved through: -

- Changes in life patterns as kitchens can be used more effectively
- Increased income through training of artisans to make and sell interventions
- Use of stoves, and windows providing light have given household members more time to engage in other economic activities such as pottery, basket weaving, beadworking, collecting medicinal plants and leisure activities.
- Reduction in cost of kerosene for lighting
- Reported savings in time and money spent in hospitals with burns, coughs, eye, and chest pains.
- Reduced losses caused by attacks on domestic fowl by wild cats, due to grills/mesh on window.
- Reported reductions in common diseases and complaints
- Increased social capital; project women have reported more visitors in the kitchen and more willingness to welcome visitors in the kitchen.

Project women report more visitors in their kitchens (photo: ITDG East Africa)

Empowerment

- Women have gained confidence in decision making on house and kitchen improvement, intervention designs and installations. They have organised group meetings on their own to discuss the indoor air pollution reduction benefits.
- The beneficiaries have been empowered through involvement in design, development and production of desired interventions.
- An increased confidence of project participants through participatory training was noted by the project staff.
- The group members feel their status in the society has been raised as other community members keep sending requests to the respective representatives.
- Project participants at the community level have been empowered to disseminate project outputs through e.g. exchange visits, carrying out demonstrations and installing interventions (e.g. improved cook stoves) with their sub-contracted artisans who can install windows, chimneys and eaves paces for interested households.
- The Kenyan project team was empowered during the project by the transfer of statistical work to the Kenya office from initial management in the UK.

Gender impact

The project targets women and children but the whole family benefits. Both men and women were involved in the project at all levels.

- Women felt more confident through disseminating knowledge to their neighbours
- Husbands became supportive of their wives' initiatives when they realised how much the comfort of their kitchens' were improved
- Interpersonal relationships built up among the women as they worked on the project

In Kajiado, women provided unpaid labour; participated in project meetings/discussions; determined the position/location of the windows and chimneys/hoods and assisted in hood design. Culturally, among the Maasai community members, it is the women who are involved in house construction. However, when the men saw the improvements and the benefits derived by their families they started helping out in the construction of interventions e.g. buying water, windows, cutting trees/twigs, mixing mud, paid for cutting of poles for repairs during window installations. They can now stay in the kitchen, a place they previously used to avoid because of indoor air pollution, and entertain their friends and take beer in the greatly improved environment.

In Western Kenya, men paid for window construction and installation while others offered artisanal skills. Generally, the men in this region are involved in house construction while the women are involved in house maintenance (smearing, installation of improved stoves, positioning and size of windows, eaves spaces).

Spouses now spend more time in the kitchen in West Kenya, sitting by the fireplace while women work, and eating food there, provided the children have left. Occasionally men will assist in the kitchen, which was not a characteristic phenomenon before the interventions were installed. The observations below describe the benefits highlighted by the community members themselves as a result of the smoke interventions. Box 6.1 is reported in the field notes in West Kenya.

Improved health

- Coughs, dizziness and chest pains relieved
- Reduced sweat and heat, so better sleep
- Less headache, malaise
- Reduction in aching eyes, tears and running nose
- Safer - smoke hood acts as a shield, preventing children and goats falling onto fire
- Snakes and rodents cannot hide in the house where there are windows
- Food free from soot contamination

Box 6.1: Reported health improvement
According to R, the husband used to suffer from asthma attacks therefore never used to go to the kitchen but after the interventions were put in place, he is now willing to assist her in some domestic jobs. Nowadays, he normally wakes up at 5.30 a.m., puts his bathing water on the fire then goes to bathe as he leaves the tea getting ready on the fire. The woman is now relieved from waking up early and doing all the household chores by herself

Improved environment and comfort

- Smoke removal
- Improved lighting and visibility through window installation
- Smell removal
- Fresh air circulation
- The hood prevents rain getting onto the fire when the roof leaks
- Men can drink beer in the cool of the house
- Introduction of new ideas: e.g. creation of more space, improved fireplace, introduction of cupboards

Child doing homework using natural light
(photo: Nigel Bruce)

Increased opportunity – income generation

- Able to sew clothes and do beadwork in the house when weather unsuitable out of doors
- Reduction in time lost through ill health
- Improved children's grades at school, as they can work indoors

Woman doing beadwork using natural light *(photo: Nigel Bruce)*

Reduced expenditure

- Reduced kerosene use due to reduced need for lighting (quoted by one householder in Kajiado; 4litres now purchased monthly instead of every two weeks by another)
- Cooking is possible using daylight through the windows
- Food stays longer without spoiling
- Can find lost items
-

Reduced drudgery

- Less soot on walls, ceilings, hair, sheets, children's books, clothes
- Easier to wash the children and do the housework
- Fire cooks faster, is easier to light, uses less fuel and can use any type of wood with smoke hood, so faster to collect.
- Can stay longer in the house (this allows tasks to be completed more quickly)
- Able to watch over calves through the windows

Negative impacts

As with any innovation, there were some negative impacts, which have been, or will be, addressed. These included:

Technical problems

- Some people felt that the kitchens are, at times, cold and draughty during inclement weather
- All the windows were made to a standard design, as this was the most cost-effective way of doing it. Some house owners would have preferred different sizes of window
- Cats could enter through the window – the cats were prevented from entering by having mesh on all windows and eaves spaces
- Leakage around the base of some of the chimneys during heavy rain – so flashing is required
- Wick lamps blow out if the windows are left open when it is very windy – so windows need to be closed, or hurricane lamps purchased

Social factors

- Some women were initially reluctant to communicate problems as they were enthusiastic to allow the project to progress unhindered
- Some people felt that thugs, sneak thieves, and peeping toms could see into their houses. Others feared it would infringe on their privacy. This was to some extent prevented by having shutters on the windows
- One cook observed that chimney hoods made it more difficult to lean over the pot to cook – however, during discussions, she agreed that she would probably get used to it.
- The smoke hood obviously takes up quite a lot of space. Women were consulted as to its position, in order to minimise this constraint
- It was assumed that there are more flies and mosquitoes when there is less smoke. However, in West Kenya the opposite was observed, as the increased air movement in the kitchens kept the mosquitoes away.

Financial aspects

The cost of the intervention was a critical factor, as the households in the study are mainly on a very low-income. The project in Kajiado footed the whole cost, due to the extreme poverty in the area, although some materials and labour were supplied by the households. In West Kenya, a cost sharing element between the household owners and the project was feasible, with about half the cost provided by the household, and also because most of the husbands were willing to provide artisanal skills in installing the interventions. The cost sharing aspect was geared to ensuring sustainability of the smoke-alleviation methods, as described in (Box 6.2).

Box 6.2: Financial arrangements in West Kenya

Discussions were held and an agreement reached with the household owners of what ITDG's contribution towards the interventions will be and what theirs will be (cost sharing element). For example, if two windows are required, ITDG contributes one and they contribute another, if three windows are required, IT contributes two of them. The windows would have wire mesh so that they can open at night while they are cooking. For the eaves spaces, ITDG contributes the wire for preventing other animals from getting into their kitchens. In all cases, they each provide a person to build. In cases where an Upesi stove is needed, the household contributes in full. The cost-sharing schedule was acceptable to all households except for three, who said they were constrained with hunger, school fees and other financial problems and thus treated differently. Most of the houses would have eaves and windows except for specific cases such as HH09 where a hood was recommended.

Financial problems
Money to purchase the materials was scarce, and expenses incurred in installation of interventions caused by the cost-sharing element were a problem. In West Kenya, though the cost-sharing arrangement was important in terms of sustainability, it did mean that some people who would have preferred smoke hoods elected to have windows instead. This may have contributed to the smaller uptake of smoke hoods in this region, as they are more expensive.

Collaboration between project team and community

Throughout the project, there was a good rapport between the community and the project team. Excerpts from the field reports in Box 6.3 reflect the collaborative nature of the work.

Box 6.3: **Collaborative activities between project team and community**

…The women in Kajiado have been very hospitable throughout the study since they spare time for the project staff. Most of them always insist on sharing a meal with the project staff especially if monitoring coincides with their meal times e.g. breakfast at around 7.00 a.m.

…NP took up the responsibility of doing the repairs of the demolished parts. She together with her women colleagues shared the task of the repairs which would have cost her a few Kenya shillings. When the Kajiado team was taking internal measurements, NA was busy plastering and filling the gaps.

…The women thanked the team for everything including the incentives (sugar, tea and flour) during the hard times especially because of the drought experienced during the interventions, and promised to give the necessary assistance to make the project a success. The meetings were usually closed with a word of prayer by the women e.g. in one meeting, NO offered a word of prayer before the participants were released.

Dissemination at community level

- Some of the project families have already expressed a need for more interventions (windows and smoke hoods) in their main/living houses – this will provide employment for the artisans who have been trained by the project. The project women have requested training by the team on how to go about with dissemination of interventions where they will be acting as the key lead.
- Members of the women's groups who were not involved in the project have made representation that they had not been trained on indoor air pollution extraction

techniques. They have suggested training local artisans (among the community members) to ensure sustainability.

- Neighbours of the women involved in the project feel that a bigger group needs to be targeted to meet the demands of the community – this will be addressed in future project work.
- The improvements have prompted several inquiries from neighbours of the household owners. One of the husbands, for example, has had many visitors inquiring about the chimney installed in his kitchen and the improved fire efficiency realised from the improved cook stoves.
- The Kenya office has used the national press to highlight the dangers of indoor air pollution, and to describe the project activities. It will now be seeking to inform the general public through this medium.
- Videos have been made in both regions, and these will be useful dissemination tools, allowing the women to discuss their own impressions of the changes which the interventions have made to their lives
- The project has shared experiences with Institute of Cultural Affairs of Tanzania (ICA - TZ), that was developing a proposal working with the Maasai community in Tanzania. The Institute had been referred to ITDG by a donor, and it is anticipated that this may lead to future collaboration.
- The project has hosted an exchange visit by a team from Munduli district in Tanzania, GTZ - Kitui and Kisii districts.
- The smoke team will consult with the Maasai Integrated Development Partnership Project (MIDPP) on their Urban Livelihoods and Shelter (ULS) Programme.
- The project has worked with Cross-border Bio-diversity project in their planning sessions, and has influenced the project to involve ITDG in the energy component on conservation of energy at Namanga Hill, Kajiado district
- The project has liaised with the local office of AMREF
- The project has influenced the Ministry of Health (MoH), Ministry of Culture and Social Services (MOCSS), and Maendeleo ya Wanawake (an organisation set up to empower and improve the status of women) to participate and to campaign for indoor air pollution reduction.
- Local leaders have been involved in indoor air pollution reduction campaigns

Chapter 7: Key findings on project methodology

The project set out to identify ways in which indoor air pollution could be effectively be alleviated in people's homes. This chapter describes key aspects of the project methodology which were essential for its success, and highlights those areas which proved to be problematic for the benefit of others working in this field.

Household selection

There was no shortage of people wanting to take part in the project. Using the women's groups as the basis for identifying houses proved very satisfactory. A participatory approach, which gave the responsibility of selecting households to the communities involved, meant that everyone was satisfied that the correct houses were being monitored

Carrying out a baseline assessment

Pollution and exposure measurement

The protocols adopted by the project enabled the team to record the unacceptably high levels of PM_{resp}, CO and PCO experienced by the communities. A fundamental constraint is that no universal protocols exist for measuring these variables, so these figures must be regarded as indicative rather than absolute. It should be noted, though, that these values reflect an order (or two) of magnitude greater than commonly accepted norms, and this would be the case even if the monitoring equipment had been sited at any realistic position relative to the fire.

Fuel use and house structure

The protocols addressed the quantity and type of fuel used most often by the study household. In future studies, determining the type of fuel used on the day of testing would allow a more rigorous statistical analysis to be performed on fuel as a confounding variable. In this study, analysis of the pre- and post-intervention results reflects no major change across each community in the type of fuel being burnt.

The houses were characterised during the baseline survey by whether they were already improved a lot, a little, or not at all. This proved somewhat subjective and it might be useful to have a 'points' system to characterise the level of improvements. However, the teams provided excellent sketches, showing the positions of key components, such as doors, windows, stoves, both before and after the interventions were installed. key questions reflected the number of windows, eaves spaces, roofing etc. which might affect the smoke levels in each house.

The enumerators were asked to record the number of hours spent, and the number of times that people collected fuel. This was found to be a rather broad classification, and future studies would try to calculate the total fuel used more accurately.

Identifying participatory ways of alleviating indoor air pollution

This aspect of the project was vital to its success. Women's group discussions allowed the field team to identify possible acceptable and appropriate ways to alleviate smoke. The community were empowered to find their own solutions to their problems, which were realised through manufacture of the interventions in collaboration with the local technical college in Kajiado, and with local artisans in West Kenya– thus providing sustainable skills in the region. The value of committed and enthusiastic local field teams, working with communities who were keen to be involved throughout the process, cannot be over-emphasized.

Monitoring methods

The monitoring methodology is a compromise between obtaining sufficiently accurate results and not intruding too much on the lives of the women involved in the study. The latter aspect is vital, or the results will not reflect the usual day-to-day activities of the woman herself. The method used proved adequately sensitive to change, since the project was looking for

substantial reductions in indoor air pollution, in order to impact on the quality of life of the cooks and their families.The methodology provided a reasonable balance between accuracy and the low levels of disruption to household routine needed to make the results meaningful.

However, one constraint is the lack of 'real time' data – at the project design stage, this type of data is both expensive to procure, and more intrusive for the cook. However, without this data, it is difficult to know how and when the cook inhales the major part of her total daily dose and some real time data would strengthen any further research considerably for the following reason: If the major part of the smoke she inhales is that which is coming directly off the fire when it is being lit, then provision of windows through which the smoke can leave the room once it has spread away from the fire will be much less effective than a hood or eaves space which prevents the smoke getting into the room in the first place.

The time period for monitoring was selected as 24hours, measured during one wet and one dry season. Since many of the women sleep in the same room as the fire, this was essential to capture her full exposure to indoor air pollution. A specific height and distance from the fire was selected, as the spatial distribution of concentrations would otherwise affect the 'before and after' nature of the study. Ideally, the results would be a lot more powerful if they could be compared to other studies being done using the same protocols. Currently no standard testing procedure has been agreed, though this may change in the forseeable future.

Problems and constraints

Technical problems

The study has been carried out in two phases to assess the impact of the project: the pre-intervention and post intervention monitoring periods. In the pre-intervention period, three rounds of monitoring were needed in both areas to capture information that was inconclusive during the earlier rounds of monitoring.

Equipment

The equipment was chosen to be as discrete as possible, for the reasons described above. However, the power supply for the air sampler was working close to its limits, and replacement of the battery pack with a standard car battery and adapter (locked securely in a wooden box) proved more successful towards the end of the project. This battery also meant that the teams did not have to recharge the PM_{resp} sampler every night, so proved less stressful on the team.

In Kajiado, the high levels of indoor air pollution meant that some of the first round of monitoring was inconclusive. The solution was to change the filters and CO monitors after six hours during the day, and over twelve hours through the night. Nevertheless, the equipment became very dirty and contaminated very quickly, therefore required regular servicing.

Initial charging of the monitors in Kenya proved unsatisfactory due to climatic conditions. The pumps erroneously recorded that the built-in batteries were fully charged, with consequent failure in the field. This problem is now resolved by using the car battery.

Monitor height

The first round of sampling was conducted with the PM_{resp} and CO monitors set at 4ft height and 4ft distance from the fire. Following an external review which advised that monitoring at 2.5 feet would aid comparative studies with other indoor air pollution projects (4ft and 2.5ft are currently used by other practitioners), the suggestion to use 2.5ft was adopted for the second round of monitoring in West Kenya. The change only became evident to the rest of the team once the results from the monitoring came from the field. As it was not feasible to monitor every house again, a sample of kitchens was monitored at both 4ft and 2.5ft, and two height monitoring was used in the post-intervention rounds.

Recording data

It is important to know exactly what decisions are made by field staff on replacement of filters etc. when low values are recorded. If staff do not replace filters etc. every time, there is a risk that the mid-sampling value and the final value are added, rather than just the final value

taken. These records should form part of the monitoring sheet filled in during the monitoring process.

Installation
Despite the hoods being in two sections, there were problems in getting them into the kitchens in Kajiado, due to the geometry of the house. This could be a factor in scaling up this type of intervention, as it requires more than one person to transport and install the hood.

Installing both hoods and windows is both time-consuming and strenuous. A lot of dust and soot is disturbed, so protective clothing must be worn. Installing the interventions into new buildings would be considerably easier.

Leader of West Kenya field team calibrating equipment before taking to the field *(photo: Nigel Bruce)*

Field work

Training
Prior to field work, the team was given training in monitoring and field techniques. The importance of the team understanding why they were making specific measurements or asking particular questions cannot be overstated.

The arduous nature of the field work under field conditions are highlighted below:

Unseasonal weather
In some areas of Kajiado, such as Oloosuyian, people had been forced to migrate to other neighboring areas (Machakos, Nairobi, Thika, and Keroriti near Namanga). Meetings were therefore dictated by the household's availability. In addition, some interventions were delayed because some of the household owners had moved away with their livestock.

Torrential rains when there should have been dry weather in the first post-intervention round (see field report – Box 7.1) meant that the final monitoring in Kajiado had to be done when the weather was just turning towards the expected rains. However, the team ensured that all the testing was done at a time when there had not been sustained heavy rain, so the fuel could be expected to be reasonably dry.

Box 7.1 - General situation during the post intervention monitoring
When the post intervention monitoring was conducted from 13th November up to 14th December 2000, the area had been hard hit by drought in the previous months therefore livestock had died in large numbers which was evidenced by the gaping skeletons across the land. Due to this calamity, most of the pastoralists were forced to move to other areas in search for greener pastures in the neighbouring districts such as Machakos, Nairobi, Namanga region and some Northern parts of Tanzania. In addition, the food surplus in the area had declined so much that the community mainly relied on relief food (maize).

Rains began in mid November and the community members were hopeful that the weather would go back to normal and ultimately some household owners had started returning home by the end of November to early December.

Travelling to the field
In both Mumias and Nyamira, the distances covered were considerable; the roads were in bad condition, especially during the rainy season, and in instances when the pumps were

troublesome, it meant visiting households late in the night. Scheduling to have start times and ending times corresponding with sunrise or sunset proved more convenient for both the households and the monitoring team.

Unreliable electricity supplies
Electricity power cuts, or no access to grid electricity at all, caused great difficulty in charging the batteries for the sampling pumps. This problem was alleviated towards the end of the project by using a car battery and adapter.

Social aspects

Local field staff
A key aspect of the success of the project was that field staff were already well known in the region; some of the field staff belonged to the communities with whom the project was working and were thus able to speak in the local language.

Determining the name and address of the cook
In Kajiado, women were known by different names, moved house within the area, and cared for different numbers of children. As the houses do not have any kind of recognised 'address' it was important to ensure that the cook was still living in the same house for each round of the study. This situation is likely to occur wherever the community is relatively mobile and where households are widely dispersed.

Determining the age of the cook and her children
Determining the age of the women and their children was difficult since it was not something which mattered to them, so they did not remember unless they produced their national identity cards or they related their dates of birth to certain historic events. In determining the age of the children, most women would relate better to the classes their children are in at school, and the monitoring team would estimate the age.

Health
In one house, a new baby had been born, and culturally this required both mother and baby to be confined, with all the windows closed and the fire alight throughout. In another house, a woman was ill during one round of monitoring. Field reports are given in Box 7.2. The situation was further exacerbated by heavy rains and cold weather, which persuaded her to keep the windows closed. As a result, the fire was on all day, and she was resting beside it. In both these instances, the levels were not representative of the day-to-day levels in that house.

Box 7.2: Monitoring in HH45

- The monitoring team went to HH45 on Thursday 16th November 2000 to inform her of the post intervention monitoring that was to start the following day. Unfortunately, S. and her husband were both ill and therefore they requested to be taken to Kajiado District Hospital. On being taken to hospital the physicians diagnosed S. and said she was suffering from Malaria while the husband was suffering from cancer of the leg. After the treatment, the couple was returned home to rest and the team was to go back once their condition was better.

- On the morning of 18th November the team went to start monitoring the house but this was not possible due to a heavy downpour making the road impassable especially because the Ol-Kejuado river transverses the road to this home. The team went back in the evening and was forced to leave the car next to the river since the car would be stuck in the mud. From there people had to trek for about 20 minutes to reach the home. The monitoring equipment was fixed at around 18.30 hours so that ample time would be left for the monitoring team members to get back to the car before dark. 12 hour readings were taken the following morning at 06.30 hours while the other readings were taken in the course of the day for a complete 24 hour cycle. The strange thing that was noted was the fact that 3 room tubes and 3 personal tubes were used throughout the study because the woman who was still sick was confined indoors and the fire was alight all through the 24 hour sampling period. Her bed was very close to the fire as compared to the distance between the fire and the other monitoring devices. She told the team that her house was very cold due to the heavy rains and therefore she tried to keep it warm by lighting the fire throughout the night and also keeping most of her windows shut.

Questionnaire design

The questionnaires were developed in consultation with staff in the regions. They have two roles: to provide an overview of the lifestyles of the people involved; to identify any changes that have taken place during the project. There are several key elements that need to be addressed in these questionnaires:

- How will the question be put to use at the end of the study?
- Does the question have the same meaning to field staff and community as it does to the staff who produce the questionnaires?
- Do we need to know , in general, about the lifestyle of the person, or do we wish to correlate data with the measurements of PM_{resp} and CO for the day that household was monitored? In the latter case, the questions must relate to the day on which the monitoring was done
- Care must be taken that every reasonable eventuality is addressed (e.g. there was some confusion about mealtimes for those people who only eat two meals a day).

Loss of houses

Three women moved out of their original houses between pre- and post-intervention, which meant that the results could not be used. One house was lost in Shukaa location after the opted for a divorce, which culturally means demolition of a house to signify the disintegration of the unit. For reasons such as these, more houses should be monitored in the pre-intervention rounds than are required for analysis.

Education

People in Nkoile (Kajiado) are very receptive to new ideas, compared to the other regions. This is attributed to the proximity to Namaga and Kajiado town, resulting in a higher level of education.

Identification, installation and development of appropriate interventions

The field teams formed the link between the communities and the whole of the project team. Belonging to, or having worked with, the communities in the area meant that the team themselves had ideas which could catalyse the initial discussions on what would be appropriate. These ideas were distilled into three key interventions. This was vital, as a random collection of interventions, all being installed, would have prevented any kind of analysis on the impact of the interventions. This approach enabled both the communities themselves, and the wider development community, to benefit from the research.

Sometimes extra 'interventions' were made during the study. For one or two of the households, it was found that a wood-rack '*Irongo'* was blocking the smoke from leaving through the eaves spaces. In these cases, the rack was repositioned. These extra interventions need to be documented systematically.

Training and maintenance

Training and maintenance was mainly conducted through women's groups, and often involved other organisations, such as the representative from the Ministry of Health. Aspects of smoke alleviation were incorporated into other health messages. By using group discussion, everyone involved was able to share advice based on their own experience, thus increasing the knowledge-base of the whole community.

Linkages with other organisations

Linkages with other organisations are important as they raise the level of awareness among a far wider group than would otherwise be the case. They also pave the way for future work in-country and in other areas within that country. A further aspect is that the project brings together practitioners from several disciplines, health, finance, energy, technology, business, and their skills can provide a holistic solution in the longer term.

Chapter 8 – Discussion

The main objectives of the project were twofold: to improve the quality of life, through reduction in indoor air pollution, for households in these study areas; and to develop a participatory methodology for further research into appropriate ways to alleviate indoor air pollution. This analyses both the successes and any constraints to success which need to be addressed in future work.

Evaluation of changes in pollution and exposure

Effect of smoke hoods

Smoke hoods were undoubtedly the most successful intervention in terms of smoke alleviation – especially as windows were installed at the same time, which provided a good draught to optimise combustion. Smoke hoods are also good because they work in all weathers. As they are more tolerant than chimney stoves to variations in geometry, they can be made to suit the cook, and still be effective, and can be copied more readily at local level.

In West Kenya, where Upesi stoves and smoke hoods were used in combination, the stove minimises the sparks going up the chimney, increasing safety where the hood is built through thatch.

Effect of eaves spaces

Eaves spaces, though not quite so effective at removing smoke, are an extension of what is happening in several of the houses in West Kenya already – so they are very well accepted. Providing a frame formalises the need to have space behind the stove for smoke to escape. Building in an Upesi stove ensured that the eaves spaces were located at the optimum position. It was noted that some of the household members who slept in the room with the eaves spaces found that it got cold at night. Further work might enable the community to collaborate with the local artisans to provide shutters for the eaves spaces that could be closed at night to alleviate this problem.

Effect of windows

Those houses with windows as their only intervention did not show any marked improvement in smoke reduction, although they had several important social benefits. However, where extraction methods, such as hoods, are in use, it is important for there to be sufficient air coming into the kitchen to 'match' the hot air leaving, and it was observed by both the team and the householders themselves, that combustion improved when the windows were opened.

Effect of stoves

There was no statistically significant reduction in indoor air pollution through using stoves. This is an important negative result, but it is not the only study which reaches this conclusion (Ballard-Tremeer,G. & Jawurek, H.H. 1996).

It has been shown that stoves reduce the need for fuelwood, which might suggest that therefore there would be a reduced quantity of products of combustion. However, the products which are damaging to health are those which are overwhelmingly emitted during the 'heating up' stage of combusion – before the fire reaches a sufficient heat to convert the fuel into carbon dioxide, rather than particulates and carbon monoxide. A three stone fire has an advantage in this respect – there are no stove walls to be heated up during the early stages, so the fire can become hotter sooner. Thus for a fire of short duration, a three-stone fire can be a fairly efficient option.

This, however, is the only advantage of the three-stone fire as much of the heat is then dissipated and is not directed at the pot. Thus the 'benefits' of the three-stone fire are counteracted by the need to use more fuel for a longer time in order to get the food cooked. This is especially true where long slow cooking is required – once the stove gets hot, then it is a much more efficient means of cooking. The excellent combustion characteristics of the Upesi stove mean that for the types of meals cooked in West Kenya, this stove provides

overall advantages in terms of cooking time, and fuel efficiency and does not increase the level of emissions. It is also safer, cleaner, and increases the prestige of the cook.

It should be noted that recent studies showing reduced indoor air pollution using stoves (Ezzati, M. Kammen, D.M., 2001) involve the use of charcoal stoves rather than stoves burning the same fuel as the three-stone fires, and it may be that the improvement is caused by fuel change rather than stove use. In the communities in West Kenya, it is unlikely that a complete change to cleaner fuel would be acceptable as residues are available 'for free', whilst charcoal has to be purchased, even though, in some of the houses, charcoal was burnt in the main house for heating rather than cooking.

Community perspectives

Throughout the project, the field teams were made welcome by all the households taking part and were often invited to share a meal. The very high percentage of households staying with the project reflects the level of ownership felt by the communities for the project, and the skill and sensitivity of the field teams. There were minor problems which should be identified.

- Asking the times at which particular meals were taken made one family cook extra meals, just to provide the data required. Though this reflects the loyalty of the cook to the project, it is regrettable that she had to make the extra effort.
- Some of the husbands felt that their wives should have been paid for the time taken to attend meetings

Community views on acceptability and affordability of interventions

Acceptability

The overwhelming feedback from the community members is that the alleviation of indoor air pollution has far exceeded their expectations and a major reason for this is the participatory nature of the project. The marked decrease in smoke and increased well-being associated with this reduction were reflected in many of the formal and informal comments made to the project teams. Nevertheless, there are outstanding concerns which need to be addressed (improving privacy, ensuring that eaves spaces can be closed in very inclement weather etc.)

Affordability

Affordability remains a major constraint to indoor air pollution alleviation. There are positive signs that, in the case of some of those living in the nearby communities, the realisation of the benefits has made them re-evaluate the cost of the interventions. Of particular note is the interest taken by the men in the communities. They are the ones who, on the whole, are in control of household finances. Having been involved in installing the interventions, it is positive to note that they are discussing interventions in terms of the comfort value of a less smoky environment. Reports from the field suggest that people are now asking how and from where they can obtain hoods and windows. Entrepreneurs to promote, manufacture and supply these interventions will form part of future work within the project areas. Funding is actively being sought to provide this next phase in scaling up.

In Kajiado, the project families were not asked to contribute to the cost of the interventions. Smoke hoods, which cost the equivalent of the cost of two goats, are deemed expensive, especially if it is only the women who benefit from them. However, the men in the Maasai community are expressing interest in the increased comfort levels in the homes with smoke hoods, and if they decide that the hoods should be installed, it is likely that this intervention will be widely adopted, since they are the ones who control most of the family income. Reducing the cost of hoods by using cheaper, but effective, materials, or seeking a subsidy, comparable to that provided for vaccination on the grounds of health, could further increase the prospects for smoke hoods.

In West Kenya, cost-sharing meant that there was strong evidence that households were willing to part with money, reflecting their level of commitment to the need to remove smoke. However, the adverse effect was that some households chose the less-costly option of eaves spaces – still effective, but not so effective as the smoke hoods they might otherwise have installed.

Empowerment of communities

Making communities aware of the risks associated with household smoke
Empowerment through knowledge is among the most cost-effective ways of improving the quality of life for those with few capital resources (Tim Allen; Alan Thomas (eds.), 2000). The participatory approach has been very powerful in addressing this key aspect of poverty alleviation. Engaging with the cooks in every aspect of the project has made them keenly aware of the risks to which their families are exposed, and has empowered them with the means to do something about it.

Members of the field team have been requested by other members of the women's groups to be kept informed on what is being done in the project. Some of the women have described to the team their feelings of responsibility for passing on the knowledge to others in their community – this has increased their social capital within the community.

Empowerment through enabling mechanisms for alleviating smoke
Poverty leaves little time or resources for dealing with tasks outside the day-to-day activities needed for survival. In this project, women's voices were heard, their advice was taken and acted upon, and their ideas were scientifically tested. This approach, balancing local skills and knowledge with technical monitoring, has ensured that the interventions which will be further disseminated are both acceptable and effective. This has empowered the community to help provide the solutions to its own problems.

Development of a national strategy for dissemination and sustainability

These results, showing a very positive impact on the families with interventions, allow proven information on interventions which are both effective and well-accepted to be disseminated within communities with similar lifestyles in the regions. These initiatives are discussed further in Chapter 8.

Exchange of experience internationally

Internationally, the work has been disseminated through:

Conferences
- Gitonga, S.; 'Addressing the indoor air pollution and household health problem in Kenya' at *USAID/WHO Technical Consultation on Health Impacts of Indoor Air Pollution in Developing Countries, 3rd to 4th May 2000, Washington, USA,* May 2000*,*
- Gitonga,S.: 'Simple Interventions to Improve Children's Health by Reducing Levels of Indoor Air Pollution - Case of East Africa' at *Children's Environmental Health (CEHN) II: A Global Forum for Action* Washington, USA, September , 2001
- Bates, E. et al: 'Improving air quality in Rural Kitchens in Kenya' at *International Conference on Biomass-based Fuels and Cooking Systems (BFCS-2000),* Pune, India, November 2000

Journal articles
- 'Safe as houses?' in *Small World, Issue 31, March 2001*
- 'Best choice for better households' *ITDG Eastern Africa Newsletter,* October 2000
- Bates, E: 'Smoke, Health and Household Energy – the link' in *DFID Energy*, November 2001
- Gitonga, S. 'Case study: Achieving Sustainable Reductions in Indoor Air Pollution and Improving Health through Participatory Community Technology Development in Rural Kenya' in *Energia News*, December 2001
- Bates, E. 'Smoke can seriously damage your health – especially if you live in the developing world' in *The Woman Engineer*, Spring 2001

Reports

- Doig, A. Indoor Smoke Pollution and Household Health; Reducing Smoke Exposure in Household Dependent upon Biomass Fuels: *ITDG Report* on First year May 1998 – April 1999
- Doig, A. Bruce, N., Bates, E. Indoor Air Pollution and Household Health: The Smoke Problem: *ITDG Interim Report* July 1999
- Doig, A., Bates, E., Bruce, N., Gitonga, S. Indoor Smoke Pollution and Household Health: Reducing Smoke Exposure in Household Dependent upon Biomass Fuels: *ITDG Report on Second Year* May 1999 to May 2000
- Kenya Smoke and Health Project 1998-2001, *ITDG Final Short Report*, December 2001

Networks

- Bates, E. 'Reducing smoke, improving lives' a case study from Kenya' *in Technology for sustainable livelihoods* website – case studies section at : *www.livelihoodtechnology.org*
- Proposed future international dissemination of best practice is described in the next chapter.

Development of a replicable participatory methodology for indoor air pollution alleviation

This methodology will form the basis for future ITDG work in international comparative studies – see next chapter. As a pilot project, this work enabled the team to test the methodology and protocols and identify shortcomings and improvements for future studies. Many of these findings have appeared throughout the text, but will be listed briefly below for convenience:

- This type of project should be participatory at all stages, and include key actors from the community including the household members, local authorities, artisans, health professionals etc. and an integrated project team.
- There is a pressing need for key technical aspects of the protocols to be standardised if findings are to be compared across projects. These aspects would include: the time over which the monitoring took place; the position of the monitors; the meaning of terms such as 'personal CO' ;types of fuel; cooking times; recording interventions; etc.
- Overall, the questionnaires reflecting household and house characteristics provided a good insight into those aspects of community life which have a direct bearing on energy use. However, it should be noted that these protocols were designed in consultation with teams who were working in the particular communities, so that the questions were locally appropriate and culturally sensitive.
- The 'before and after' nature of the project meant that certain changes took place which could not be avoided – weather, number of people in the household, availability of food and fuel etc. For more rigorous analysis of these confounding variables, it might be considered more effective to identify what the household uses by way of fuel and food on the day of monitoring, rather that seeking to identify what they identified as their staple requirements (e.g. dried maize distributed during famine will affect cooking time, but is not in the usual diet of the Maasai community). This, however, might make it more difficult to characterize the lifestyle of the community. Care must be taken not to overload the individual householder with questions – only those questions should be asked which can realistically be part of the overall analysis.

Chapter 9 – Future work

Local level

At the time of publication (January 2002), he project team in Kenya is actively seeking funding for follow-on work to scale up those interventions which have proved most successful. Scaling up activities which have been identified include:

- Working with other NGOs such as AMREF, and local government offices, to provide support for dissemination and further installation of smoke-reducing interventions
- Dissemination through extra women's groups, health centres, schools
- Forming committees on smoke-free environments
- Forming health committees on environmental health at village level
- Running capacity-building workshops for artisans manufacturing devices for reduction of indoor air pollution
- Introducing a child to child programme on indoor pollution campaigns
- Running workshops on indoor air pollution study findings, and community awareness

International level

The findings from this project will be disseminated through:

- International conferences, including;
  - Bruce, N. et al: ' Reducing indoor smoke pollution through participatory technology development in rural Kenya' to be presented at *Indoor Air 2002,* Monterey, USA, 2002
  - Doig, A.: ' Household Energy, indoor air pollution and health – experiences in Kenya' to be presented at the World Renewable Energy Congress, Cologne, Germany 2002
- Further dissemination through journals, including *Boiling Point* and through websites, including the HEDON website

One aspect of the project was enable ITDG to evaluate the success or otherwise of a participatory approach to smoke alleviation. The methodology has shown itself to be very effective, and a similar approach will be adopted in a new project, funded by the UK government Department for International Development. This project will involve communities in Nepal and Sudan, as well as looking at the urban context in Kenya. It is hoped that the three-country project, currently funded, will lead directly to a scaling-up phase and enable the lessons learnt to be applied on a sustainable and commercial footing. Funding is currently being sought towards this end.

Funding is also being sought for scaling up successful interventions within Maasai communities in Tanzania and Uganda.

Annex 1: The scientific process

Study methods

The overall study employed a 'before-and-after' comparison in the two study areas. One year of baseline monitoring followed by interventions over 6-9 months, then a further year of follow-up monitoring (total 2.5 years).

This design was judged most appropriate given the participatory nature of the development work, which would have made use of parallel control (non-intervention) areas very difficult to justify and maintain. Although this design left the study open to influences other than those implemented by the project, the methodology was deemed to be appropriate in communities where changes evolve slowly. The range of other factors that might influence pollution levels and exposure were measured during the course of the study, and changes over the course of the project assessed. In addition, the assessments of pollution and exposure were repeated twice per year both before and after the interventions, to allow characterisation of within-house variation across the wet and dry seasons of the year and more precise estimates of the true effects of the interventions to be obtained.

Sample

A total of 50 houses (25 per area) were sampled. The criteria for sampling were that:

- the house structure should be typical
- the family were interested in the project objectives,
- they should be prepared to accept the questionnaires and monitoring over the 2.5 years of the study, and
- they should be keen to implement changes to the homes in consultation with ITDG staff
- the households should preferably include children aged under five years, as these are the households where women spend most time in the kitchen

Although it was recognised that this was not a random sample, the houses selected were considered to be typical for the communities involved.

Pollution assessment

Particulates

Particulates: 24 hour respirable particulates (approximate aerodynamic diameter 5 microns or less) were measured in houses using a Buck I.H. pump sampling at 2.2 litres/minute, a Higgins-Dewell type cyclone and 35 mm glass fibre filters (Whatmann) – this equipment conforms to BSEN-481 for inhalable thoracic response.

The pumps were calibrated using a Munro RM1069 rotometer prior to each sampling period. The cyclone was placed at 4 feet above the floor of the kitchen, and 4 feet horizontally from the hearth (in Maasai kitchens it is typically difficult to exceed this distance due to the small size of the room). Due to the very high levels of pollution, filter cassettes were changed after 12 hours to avoid clogging. The equipment was designed such that, if the sampling flow rate dropped by 5% or more, the Buck pump sampler suspended air sampling, and recorded the elapsed time and volume sampled before shutting down.

Carbon monoxide

Carbon monoxide (CO) was measured in the kitchens using Gastec 1D (1000 ppm/hr) diffusion tubes co-located with the cyclone. The purpose of this is twofold:

- The main purpose was to allow the use of CO personal exposure assessment (see below) as a proxy for PM_{resp}, as this avoids the use of cumbersome personal pumps which seems certain to interfere with normal daily activities. This method of exposure assessment is similar to that used in recent studies in Guatemala, and has shown promising results with correlation coefficients between room 24 hr integrated $PM_{2.5}$ and CO in excess of r=0.9 (Naeher, '96).
- The second reason for measuring CO was the potential for direct health effects of what appear to be very high levels in the kitchen.

Up to three tubes were used during the 24 hours, depending on the levels of pollution.

Personal exposure assessment

CO level

Twenty-four-hour integrated CO exposure for each cook was measured using a Gastec 1D 1000 ppm/hr diffusion tube. This was placed in a holder and clipped to clothing on the left upper chest. The woman was asked to place the tube/holder near her head when sleeping. Generally one and two tubes were used during the 24 hours depending on the levels of pollution (in one instance three tubes were used when the woman was ill and indoors all day).

Time-activity assessment

The index woman was asked to recall her activities, and those of the three youngest children who usually live in her house, for the same period as for air and personal sampling. To aid recall, the day was divided up into hour-long periods. The purpose of this assessment was::

- To provide an alternative source of information about exposure
- To allow interpretation of personal CO levels before and after the interventions, which are influenced by both ambient levels of pollution, and the time spent in polluted and environments. Both of these factors could be altered by the intervention: thus, reduced room pollution levels may not result in lower human exposures if the women and children 'compensate' by spending more time in the home.
- To provide information on the exposure of young children.

Data collection

Information on the household, house construction (windows, doors, ventilation), stove type, fuel used for various purposes, and cooking (foods cooked, numbers cooked for) during the air/personal sampling period, was collected in the two areas, using a standard questionnaire developed for the purpose. Symptoms of chronic obstructive lung disease (COLD) among the index women were also assessed, using a questionnaire developed by the Medical Research Council, with minor modifications to allow for local symptom terminology and seasonal patterns. In view of the relatively small sample size (n=50), and the nature of the sample (non-random), these questions were included only as an initial exploration of the extent of COLD in these populations. Symptoms of eye discomfort were also reported.

Laboratory methods (filters)

Filters for gravimetric analysis were prepared using standard procedures, in the Department of Analytical Chemistry, University of Nairobi. The filters were dried, and then weighed on a 6-place balance, prior to insertion into the cyclone cassettes, labelling and despatch to the field. On return from the field, the filters (still in cassettes) were dried, and then re-weighed. Regular checks were made on calibration of the balance, and laboratory blank filters used to check quality control.

Field supervision and quality assurance

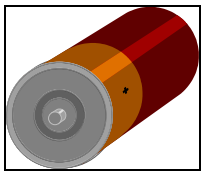
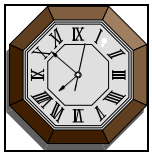
Each of the two field teams had a supervisor who was responsible for preparation of the questionnaires, CO tubes, filter cassettes and air sampling equipment (charging and calibration) for each house visit. The supervisor directly observed approximately 50% of household assessment (air sampling and questionnaires). Around 10% of questionnaires were repeated independently by the supervisor. On return from the field, the supervisor re-checked and recorded the stored pump data (time elapsed, volume sampled, flow rate). The room and personal CO diffusion tubes were sealed at the end of the sampling period, and re-read blind by the supervisor (for analysis the mean of the field worker and supervisor readings was used). A proportion of filters prepared in the laboratory were used as blanks, and returned from the field unused to act as controls.

Equipment and technical support

Equipment was supplied by Munro Group, Gilbert House, 406 Roding Lane South, Woodford Green, Essex IG8 8EY, UK. The representative of this company has given expert technical support and advice to the project team throughout the project.

Annex 2 – Sample pages from monitoring questionnaires

1. Sample page from protocol for preparing equipment

#	Step	Reminder!	Field
1.	**Complete Fields 1-4 of data collection form.**		1 - 4
2.	**Check flow rate of pump:** • Place "practice" cassette in cyclone, and ensure that the cyclone lid is securely tightened to avoid leaks (but do not overtighten). • Connect air flow meter, and ensure on flat stable surface • Switch on pump, ensure pump fully charged (it will read about 107%) • Scroll to sampling mode, and press enter to start sampling. • Allow 1-2 minutes to stabilise, and check whether flow meter (top of red float is level with upper red line, 2.2 litres/minute: ***make sure your eye is at same level as the red line!!***). • Record flow rate from flow meter, before re-calibration If the flow rate is 2.2 litres/min, go on to **Step 4**. If not, go to **Step 3** to re-calibrate the pump.	 Is the pump battery fully charged?	5
	•		
3.	**Re-calibrate pump:** • Change to configure mode. • Clear ***all*** settings. • You may wish to switch the configure security code off at this stage. • Ensure "practice" cassette in cyclone, and flow meter is attached. • Change to sampling mode. • Press enter to begin sampling, and adjust the flow using the UP and DOWN arrows until flow rate is exactly 2.2 litres/min. Use technique as described in Step 2. • Wait until the display instructs you to press "enter", then do so. • Adjust the four digit display to read 2200 cc/min, and then press enter again. • You will be asked whether to activate the keypad lock and configure security code at this stage: it is suggested you do this ***after*** you have cleared the elapsed time/volume sampled display (Step 4).	Don't forget to keep you eye at same level as red line when checking flow meter!! 	
4.	**Clear time elapsed and total volume sampled:** • Change to configure mode. • When asked whether to clear all settings, enter **no** (otherwise you will erase the flow rate calibration!!) • Clear elapsed time (and volume) only?, change to yes, and enter.		

2. Sample page from data collection form (second page)

15.	**Position pump and cyclone:** • Connect cyclone to pump, and ensure cyclone lid securely tightened, and pipes well connected. • Identify site used in pre-intervention monitoring for **cyclone** (In kitchen, 4ft above floor level, at least 4-5 feet from fire, and away from smoke rising directly from fire). ***Please use the same site as used in pre-intervention monitoring*** • Fix pump and cyclone securely. Ensure cyclone is upright.	**Height of cyclone above floor level?**	15
16.	**Switch on pump:** Switch on (press **on/hold** button): pump in **sampling** mode. Record temperature	Temperature = deg C	16
	• Record time of day (24 hour clock)		17
	• Record atmospheric pressure from barometer	Pressure =	
17.	**Begin sampling:** • Ensure that the elapsed time is zero (0:00). If not, you will need to go into **configure** mode and clear the time and volume - see Preparation protocol Step 4. • Start pump sampling (press **enter**).		
	• Allow pump to stabilise, which may take 1-2 minutes. Check: is the flow rate between **2100** and **2300** cc/min ? Enter **Yes** or **No**		18
	If the flow rate is **not** between 2100 and 2300: • *make sure the tubes are not kinked, and are connected securely.* • *make sure the cassette is in the right place, the cyclone lid is securely fastened, and the cyclone inlet tube is not blocked.* <u>If , after checking these, the flow rate is still not within the specified range, the sampling should be stopped and the pump re-calibrated.</u>		
18.	**Start the room CO diffusion tube (Type: Gastec 1D):** • Select plastic tube holder with the **house number,** and **"room"** already written on it. • Break end of tube • Insert tube in holder, and place next to cyclone • Dispose of broken glass end in bag.	**Write in the ID Number of the room tube here:**	

3. Sample page of household questionnaire

Note to interviewer:
This questionnaire is set out in two parts. The ***first*** part should be administered before the air sampling period begins. The ***second*** part is to be administered on completion of the air sampling, and refers to the previous 24 hours - which is the period of air sampling.

PART A: QUESTIONS TO BE ASKED BEFORE STARTING THE AIR SAMPLING

#	Question		Data	Field
1	**Household number**			1
2	**Date of interview**			2
3	**Time of day** (24 hour clock)			3
4	**Name of interviewer**			4
5	**Name of interviewee**			5
6	**Age:** How old are you? [Please enter exact age if known, otherwise enter code number of the appropriate age group, (e.g. 4 for age group 30-34)]: 15-19 (1) 45-49 (7) 20-24 (2) 50-54 (8) 25-29 (3) 54-60 (9) 30-34 (4) 60-64 (10) 35-39 (5) 65+ (11) 40-45 (6)			6
7	**Number of adults usually living in the house**			
	• Males			7
	• Females			8
8	**List details of ALL children usually living in the house, UP TO AGE FIVE YEARS, starting with the youngest.**			
	Child 1(youngest)	Sex: (Female=1, Male=2)		9
		Age: Years and months		10
	Child 2	Sex: (Female=1, Male=2)		11
		Age: Years and months		12
	Child 3(oldest)	Sex: (Female=1, Male=2)		13
		Age: Years and months		14
9.	**What times of day do you usually cook meals?** *(Please enter the actual time of day, spanning the time to cook, using the 24 hour clock)*			
	Breakfast			15
	Lunch (middle of day meal)			16
	Tea			17
	Dinner			18

4. Sample page of house and kitchen characteristics questionnaire

#	Item	Data	Field
1	**Household number**		1
2	**Location/Area**		2
3	**House type: level of improvement** 1- very traditional 2- traditional, minor improvements 3- substantial improvements		3
	If 2 or 3: briefly describe type of improvements:		4
4	**Kitchen type:** 1- part of main house 2- separate building		5
5	**Type of roof:** Others: please specify 1- mud or cowdung 2- ferro-cement 3- Iron sheets 4- Thatch		6
6	**Permanent ventilation in roof** (this includes holes/vents deliberately inserted into roof, <u>other than</u> eave spaces) 1- None 2- Small (less than 3 inches in diameter) 3- Large (more than 3 inches in diameter) 4- Other (describe)		7
7	**Eave spaces:** 1- almost none, or none 2- moderate 3- large		8

Annex 3: Time-Activities Study of a typical Maasai household

Dry Season		
Hour	**Activities**	**Fire?**
12.00	At 12.00 m/n cover fire, put on githiri. 00.30 mother goes to sleep.	
01.00	Sleep	
02.00	Sleep	
03.00	Sleep	
04.00	Wake, light fire, make tea. Milk cows	
05.00	Prepare water cans Take tea	
06.00	Load donkeys	
07.00	Leave for water point	
08.00	Getting water	
09.00	Getting water	
10.00	Getting water, watering animals	
11.00	Watering animals	
12.00	Load donkeys and fill cans	
13.00	Return home	
14.00		
15.00		
16.00	Arrive back at home, rest. Light fire (4.30), prepare tea, wash dishes. Serve children tea	
17.00	Food on to cook, prepare vegetable	
18.00	Serve food for all family members. Collect wood	
19.00		
20.00		
21.00	Boys and girls help with milking. Boil milk and make tea.	
22.00	Prepare supper, then wash dishes.	
23.00	Eat supper, children to bed.	

Wet Season		
Hour	**Activities**	**Fire?**
12.00	Sleep	
01.00	Sleep	
02.00	Sleep	
03.00	Sleep	
04.00	Wake. Light fire, make tea. Take tea.	
05.00	Milk cows	
06.00		
07.00	Clean calf pen	
08.00	Release livestock, clean goat's kraal.	
09.00	Clean house, mend leaking roof	
10.00		
11.00	Light fire to help dry house. Clean calabashes.	
12.00	Separate goat kids from mothers. Prepare to go for fire wood. Feed children.	
13.00	Go to collect wood	
14.00	Collect wood, return 15.00	
15.00	Rest while making handcraft.	
16.00	Go for water nearby.	
17.00	Close livestock in the dock because of rains.	
18.00	Milk cows	
19.00	Separate calves from cows.	
20.00	Family in house and children go to bed.	
21.00	Prepare calabash for next morning.	
22.00	Mother goes to sleep.	
23.00	Sleep	

Annex 4: Statistical method

Sample size and power

The sample size requires to be large enough to demonstrate useful changes in pollution levels and exposure for the two area samples combined, and also for sub-groups as defined by the type of intervention and location.

Based on alpha level of 0.05, power of 80%, pre-intervention 24 hour mean PM_{resp} (respirable) level of 1500 $\mu g/m^3$, standard deviation of 500 $\mu g/m^3$, and reduction to be detected of 33% (to a mean level of 1000 $\mu g/m^3$), this yields n=16 per group for an unpaired analysis, and n=10 for a paired analysis. Paired analysis is appropriate as the same houses were compared before and after the interventions.

The analysis

The main analysis consisted of the following steps:

- Descriptive analysis of house and household characteristics and how they have changed during the project
- Assessment of the mean pre- and post-intervention levels and differences in kitchen pollution and personal exposure overall (both areas combined), and by area.
- Assessment of the pre- and post-intervention difference in kitchen pollution and personal exposure by three broad types of intervention, with (a) both areas combined, and (b) areas analysed separately.
- Analysis of the association between room CO and PM_{resp}
- Analysis of changes in potential confounding factors associated with kitchen pollution and personal exposure levels, such as temperature, rainfall, meal servings etc.

Data handling

Data was entered in Microsoft Access, and all entries were rechecked by a second person.
All data analysis was conducted using SPSS

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Reducing indoor air pollution in rural households in Kenya:

Working with communities to find solutions

ITDG project 1998-2001

It is now accepted that indoor air pollution is one of the major causes of death and ill-health in low-income communities. Those mainly affected are women and children, as they are the ones who are usually in the kitchen when cooking fires are being used. Substantial efforts to reduce indoor air pollution need to be made if the impact on women's and children's health is to be commensurate with the gravity of the problem.

The study described in this publication has addressed the problem using a participatory approach. It is being run by ITDG, in collaboration with the Department of Public Health, University of Liverpool and the University of Nairobi, Kenya.

The project has found appropriate and sustainable ways to reduce smoke substantially in the kitchens of low-income communities in two regions of Kenya; a Maasai community in the Kajiado region south of Nairobi, and an Abaluhya community in Western Kenya.

The technologies used in the project have not been the starting point of the work, but rather, they have come out of discussions with members of those communities into how they feel their needs can best be met. In the Maasai community, windows and smoke hoods have been installed in the project houses, whilst in West Kenya, the community members chose improved stoves, eaves spaces and smoke hoods.

The impact of these technologies has been assessed both in terms of reduction in indoor air pollution, and in the benefits identified by the community members themselves.

Small farms

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Tree Crops

A Permanent Agriculture

by

J. Russell Smith, Sc.D.

First published in 1929

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Tree Crops: A Permanent Agriculture

Tree Crops: A Permanent Agriculture by J. Russell Smith is the classic work on tree crops. First published in 1929, this highly readable blueprint for the development of high-yield tree crops proves that vast, untapped food sources can be harvested from common species of North American trees.

Smith's philosophy is based on the idea that agriculture must be "adapted to physical conditions," that "farming should fit the land." He observed worldwide the catastrophe of hill agriculture whose one-time cycle he described so accurately as "forest -- field -- plow -- desert."

Wendell Berry, one of our most important ecological voices, has written a compelling introduction on the need for utilizing these still-revolutionary ideas, for Smith's plans were never adopted to the degree he wished. And the potential for erosion control, increasing human and animal food supply, and diversifying our ecosystem remains as great a challenge as it was when *Tree Crops* was first published more than fifty years ago.

-- "*Tree Crops* made so much sense to me that I have never been the same since... As my work took me all over the world, everywhere I could see it, thanks to Russell Smith: Agriculture in mountainous, rocky, or dry regions is a disaster, but trees are salvation." -- E. F. Schumacher

-- "Here is one of the most important books of our time. It relates ecology, national economics and human welfare in a way that is fascinating for anyone interested in the basic problems of the nations ... Also, a very practical and profitable investment." -- Louis Bromfield

Dedication

This book is dedicated to

Charles C. Harrison
Edgar F. Smith
Josiah H. Penniman

Three provosts of the University of Pennsylvania whose sympathetic understanding and practical aid were of great assistance in the prosecution of the researches which resulted in this book.

Foreword

How to read this book

This book can be read in three ways -- depending on your hurry or your interest.

First, look at the pictures and the legends and you have the essence of it.

Second, read the first three short chapters and you have the idea. This might be followed by chapters 24 and 26 to get a similar general statement of the applications.

Third, if you are still interested, the table of contents or the index will guide you into the main body of supporting data.

NOTE

Only the Introduction, Chapters 1, 2 and 3, and Chapters 24 and 26 are reproduced here in this online edition, so that, as Smith says above, "you have the idea". Once you have the idea, your appetite should be whetted -- you'll want more, and there's plenty more in the other chapters. Buy the book, it's a treasure-trove. From Island Press:
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2. Tree Crops -- The Way Out
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6. A Stock-Food and Man-Food Tree -- The Carob
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11. The Persimmon: A Pasture Tree for the Beasts and a Kingly Fruit for Man
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UK AGRICULTURAL BIODIVERSITY COALITION

Updated 29 June 2004

International Seed Treaty became law on 29 June 2004: concerns that it will not defend free access to seeds.

Trade debates limit biodiversity-enhancing measures but new GM export regulations approved. Reports from CBD/COP7 & MOP1, Kuala Lumpur, Malaysia 9 - 27 February 2004

Karen Commitment to Livestock Keepers Rights agreed at Livestock Genetic Resources and Agricultural Biodiversity workshop. Nairobi, October 2003. Proceedings now available.

"GM Crops are irrelevant to hunger eradication": UK Food Group Briefing released as UK government reports that benefits of GM crops 'not proven'. Science Review, UK Farm Scale Evaluation trials show environmental damage in most cases

- ECO - NGO newsletter post CBD / COP 7 (11 June 2004)
- CBD COP 7 & MOP 1, Kuala Lumpur, 9 - 27 Feb 2004
- Civil Society groups criticise CGIAR and the NGO Committee 'freezes' its engagement with the CGIAR. More...
- CSO Forum for Food Sovereignty follow-up and more...
- Genetic Futures in
- WSF IV 16 - 21 January 2004
  Mumbai, India

  World Social Forum III Reports and Reflections in "Patrick's Postcards from Porto Alegre"
- UK Intellectual Property Rights Commission launches report that shows that "IPRs do not reduce poverty".
- GM Food Aid scandal
- WSSD: the Biotech Bonanza

  WSSD became the stage for US demands to accept biotech and GM Food Aid. More...

  ITDG Briefing "Preserving the Web of Life".
- International Seed Treaty (ITPGRFA) Treaty came into force on 29 June 2004 - Updates, CSO commentary and key links. More ...
- Reports on Agricultural Biodiversity Conservation research
  Joint ITDG/ODI research on farmer conservation methods in Kenya, Peru and Zimbabwe

Food and Farming:report on and background to London pre CBD / COP 6 Seminar on 27 March 2002

agricultural biodiversity

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Internet Search on **agricultural biodiversity** for current links. Use UK*abc*Site Search, to search within this site.

UK*abc* website home page http://www.ukabc.org

WHAT IS AGRICULTURAL BIODIVERSITY?

Agricultural biodiversity of all food species is a vital sub-set of general biodiversity, highly threatened by globalisation of food markets and tastes, intellectual property systems and the spread of unsustainable industrial food production, but it provides the basis of the food security and livelihood security of billions of people and the development of all food production, including for industrial agriculture and for the biotechnology (Life) industries. It is the first link in the food chain, developed and safeguarded by farmers, herders and fishers throughout the world.

Although the term "agricultural biodiversity" is relatively new - it has come into wide use in recent years as evidenced by bibliographic references - the concept itself is quite old. It is the result of the careful selection and inventive developments of farmers, herders and fishers over millennia. Agricultural biodiversity is a vital sub-set of biodiversity. It is a creation of humankind whose food and livelihood security depend on the sustained management of those diverse biological resources that are important for food and agriculture. Agricultural biodiversity, also known as agrobiodiversity or the genetic resources for food and agriculture, includes:

- Harvested crop varieties, livestock breeds, fish species and non- domesticated ('wild') resources within field, forest, rangeland and in aquatic ecosystems;
- Non-harvested species within production ecosystems that support food provision, including soil micro-biota, pollinators and so on; and
- Non-harvested species in the wider environment that support food production ecosystems (agricultural, pastoral, forest and aquatic ecosystems).

Agricultural biodiversity results from the interaction between the environment, genetic resources

and the management systems and practices used by culturally diverse peoples resulting in the different ways land and water resources are used for production. It thus encompasses the variety and variability of animals, plants and micro-organisms which are necessary to sustain key functions of the agro-ecosystem, its structure and processes for, and in support of, food production and food security (FAO, 1999).

Agricultural biodiversity has spatial, temporal and scale dimensions especially at agro-ecosystem levels. These agro-ecosystems - ecosystems that are used for agriculture - are determined by three sets of factors: the genetic resources, the physical environment and the human management practices. There are virtually no ecosystems in the world that are "natural" in the sense of having escaped human influence. Most ecosystems have been to some extent modified or cultivated by human activity for the production of food and income and for livelihood security.

Agro-ecosystems may be identified at different levels or scales, for instance, a field/crop/ herd/pond, a farming system, a land-use system or a watershed. These can be aggregated to form a hierarchy of agro-ecosystems. Ecological processes can also be identified at different levels and scales. Valuable ecological processes that result from the interactions between species and between species and the environment include, inter alia, biochemical recycling, the maintenance of soil fertility and water quality and climate regulation (e.g. micro-climates caused by different types and density of vegetation). Moreover, the interaction between the environment, genetic resources and management practices determines the evolutionary process, which may involve, for instance, introgression from wild relatives, hybridization between cultivars, mutations, and natural and human selections. These result in genetic material (farmers' crop varieties or animal breeds) that is well adapted to local abiotic and biotic environmental variation.

So, agricultural biodiversity is not only the result of human activity but human life is dependent on it not just for the immediate provision of food and other goods, but for the maintenance of areas of land that will sustain production and for the maintenance of the wider environment.

Agro-ecosystems comprise polycultures, monocultures, and mixed systems, including crop-livestock systems (rice - fish), agroforestry, agro-silvo-pastoral systems, aquaculture as well as rangelands, pastures and fallow lands. Their interactions with human activities, including socio-economic activity and sociocultural socio-cultural diversity, are determinant. Some of the key functions for maintaining stable, robust, productive and sustainable agro-ecosystems may include the following:

- breakdown of organic matter and recycling of nutrients to maintain soil fertility and sustain plant and consequently animal growth;
- breakdown of pollutants and maintenance of a clean and healthy atmosphere;
- moderation of climatic effects such as maintaining rainfall patterns and modulation of the water cycle and the absorption of solar energy by the land and its subsequent release;
- maintenance and stability of productive vegetative, fish and animal populations and the limitation of invasion by harmful or less useful species;
- protection and conservation of soil and water resources, for example through a vegetative cover and appropriate management practices, and the consequent maintenance of the integrity of landscapes and habitats;
- sequestration of CO2 by plants.

(FAO, 1999)

This was discussed at an international Agricultural Biodiversity workshop organised by the Food and Agriculture Organization of the United Nations (FAO) and the Convention on Biological Diversity (CBD) where the multiple dimensions of agricultural biodiversity were also

summarised as providing for:

- i. Sustainable production of food and other agricultural products emphasising both strengthening sustainability in production systems at all levels of intensity and improving the conservation, sustainable use and enhancement of the diversity of all genetic resources for food and agriculture, especially plant and animal genetic resources, in all types of production systems.
- ii. Biological or life support to production emphasising conservation, sustainable use and enhancement of the biological resources that support sustainable production systems, particularly soil biota, pollinators and predators.
- iii. Ecological and social services provided by agro-ecosystems such as landscape and wildlife protection, soil protection and health (fertility, structure and function), water cycle and water quality, air quality, CO2 sequestration, etc.

A DEFINITION OF AGRICULTURAL BIODIVERSITY

The variety and variability of animals, plants and micro-organisms used directly or indirectly for food and agriculture (including, in the FAO definition, crops, livestock, forestry and fisheries). It comprises the diversity of genetic resources (varieties, breeds, etc.) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (e.g. soil micro-organisms, predators, pollinators and so on) and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic), as well as the diversity of the agro-ecosystems themselves.

It has also been defined as:

Agricultural biodiversity encompasses the variety and variability of animals, plants and micro-organisms which are necessary to sustain key functions of the agro-ecosystem, its structure and processes for, and in support of, food production and food security. (FAO, 1999)

WHAT IS HAPPENING TO AGRICULTURAL BIODIVERSITY?

These locally diverse food production systems are under threat and, with them, the accompanying local knowledge, culture and skills of the food producers. With this decline, agricultural biodiversity is disappearing and the scale of loss is extensive and with the disappearance of harvested species, varieties and breeds goes a wide range of unharvested species.

- More than 90 per cent of crop varieties have disappeared from farmers' fields;
- Half of the breeds of many domestic animals have been lost.
- In fisheries, all the world's 17 main fishing grounds are now being fished at or above their sustainable limits, with many fish populations effectively becoming extinct.

The genetic erosion of agricultural biodiversity is also exacerbated by the loss of forest cover, coastal wetlands and other 'wild' uncultivated areas, and the destruction of the aquatic environment. This leads to losses of 'wild' relatives, important for the development of biodiversity, and losses of 'wild' foods essential for food provision, particularly in times of crisis.

WHAT ARE THE UNDERLYING CAUSES OF THE LOSSES OF AGRICULTURAL BIODIVERSITY?

There are many causes of this decline, which has been accelerating throughout the 20th century in parallel with the demands of an increasing population and greater competition for natural resources. The principal underlying causes include:

- The rapid expansion of industrial and Green Revolution agriculture, intensive livestock production, industrial fisheries and aquaculture (some production systems using genetically modified varieties and breeds) that cultivate relatively few crop varieties in monocultures, rear a limited number of domestic animal breeds, or fish for, or cultivate, few aquatic species.
- Globalisation of the food system and marketing, and the extension of industrial patenting and other intellectual property systems to living organisms, which have led to the widespread cultivation and rearing of fewer varieties and breeds for a more uniform, less diverse but more competitive global market.

As a consequence there has been:

- Marginalisation of small-scale, diverse food production systems that conserve farmers' varieties of crops and breeds of domestic animals, which form the genetic pool for food and agriculture in the future.
- Reduced integration of livestock in arable production, which reduces the diversity of uses for which livestock are needed.
- Reduced use of 'nurture' fisheries techniques, that conserve and develop aquatic biodiversity.

Genetic erosion is the loss of genetic diversity, including the loss of individual genes,102 and the loss of particular combinations of genes (i.e. of gene-complexes) such as those manifested in locally adapted landraces. The term “genetic erosion” is sometimes used in a narrow sense, i.e. the loss of genes or alleles, as well as more broadly, referring to the loss of varieties. The main cause of genetic erosion in crops, as reported by almost all countries, is the replacement of local varieties by improved or exotic varieties and species. As old varieties in farmers’ fields are replaced by newer ones, genetic erosion frequently occurs because the genes and gene complexes found in the diverse farmers’ varieties are not contained in toto in the modern variety. In addition, the sheer number of varieties is often reduced when commercial varieties are introduced into traditional farming systems. While some indicators of genetic erosion have been developed, according to FAO (1996, 1998) there have been few systematic studies of the genetic erosion of crop genetic diversity which have provided quantifiable estimates of the actual rates of genotypic or allelic extinction in PGRFA. Nearly all countries say, in Country Reports to FAO in 1996, that genetic erosion is taking place and that it is a serious problem.

Variety replacement is the main cause of losses. The replacement of local varieties or landraces by improved and/or exotic varieties and species is reported to be the major cause of genetic erosion around the world. It is also cited as the major cause of genetic erosion in all regions except Africa. Examples are mentioned in 81 Country Reports, of which a number are highlighted below. • A survey of farm households in the Republic of Korea showed that of 14 crops cultivated in home gardens, an average of only 26% of the landraces cultivated there in 1985 were still present in 1993. The retention rate did not exceed 50% for any crop, and for two

crops it was zero. These results are disturbing as such home gardens have traditionally been important conservation sites, especially for vegetable crops.103 • In China, in 1949, nearly 10,000 wheat varieties were used in production. By the 1970s, only about 1,000 varieties remained in use. Statistics from the 1950s show that local varieties accounted for 81% of production, locally produced improved varieties made up 15% and introduced varieties 4%. By the 1970s, these figures had changed drastically; locally produced improved varieties accounted for 91% of production, introduced varieties 4% and local varieties only 5%. (FAO 1996, 1998)

GRAIN is an international non-governmental organisation which promotes the sustainable management and use of agricultural biodiversity based on people's control over genetic resources and local knowledge.

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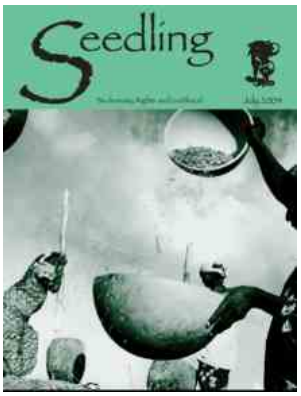

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4 August 2004

by Carlos M. Correa
August 2004

Developing countries have entered into a large number of bilateral investment treaties (BITs) as well as free trade agreements (FTAs) that include explicit obligations for the protection of intellectual property rights as "investments". These agreements fall outside the arena of multilateral standard-setting on intellectual property rights, and are being strategically pushed by developed countries to advance their industries' economic interests.

This study examines whether and how bilateral and regional investment instruments increase the scope and availability of IPR protection beyond current standards, reduce flexibilities available to developing countries under international treaties and can be used to expand the application in their territories of IPRs over biodiversity.

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What we are witnessing is not a failure of the WTO, but an open attempt to speed through liberalisation measures via bilateral or sub-regional negotiations.

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Plant diversity slipping away, report warns

Tuesday, September 21, 1999

By Margot Higgins

Courtesy USDA

Loss of habitat, pressure from non-native species, and over-harvest have put one out of every eight plant species at risk of extinction, according to the World Conservation Union.

The widespread loss of plant diversity is eroding the foundations of agricultural productivity and threatens other plant-based products used by billions of people worldwide, according to a study released Saturday by the Worldwatch Institute.

Loss of habitat, pressure from non-native species, and overharvesting have put one out of every eight plant species at risk of extinction, according to the World Conservation Union.

"Plants provide us with irreplaceable resources," said John Tuxill, author of Nature's Cornucopia: Our Stake in Plant Diversity. "The genetic diversity of cultivated plants is essential to breeding more productive and disease resistant crop varieties. But with changes in agriculture, that diversity is slipping away."

The report points out that farmers in China were growing an estimated 10,000 wheat varieties in 1949 but only 1,000 by the 1970s. And Mexican farmers are raising only 20 percent of the corn varieties they cultivated in the 1930s.

"Biotechnology is no solution to this loss of genetic diversity," said Tuxill. "We are increasingly skillful at moving genes around, but only nature can create them. If a plant bearing a unique genetic trait disappears, there is no way to get it back."

Farmers have been cross breeding plant varieties for thousands of years, Tuxill points out. "But in recent years, biotechnology has become synonymous with genetic engineering and other techniques of manipulating the genetic makeup of organisms in ways that do not occur in nature," he explains.

The effects of plant loss extend far beyond agriculture according to Tuxill's report. "One thing I hope the paper conveys is that losses of plant diversity undermine the welfare of both developing and industrialized countries," he said.

"People in developing countries — particularly in rural areas — tend to use plant resources more directly for meeting their material needs (such as fuel wood for cooking food, or herbs in traditional medicine). Developing countries also harvest plant products more extensively for direct income generation ... when these plant products are over-harvested or otherwise decline, residents in developing countries often feel the effects directly in their lives," Tuxill wrote in an e-mail.

In industrialized nations, plant diversity is used more indirectly. For example, one in every four medicines prescribed in the United States is based on a chemical compound originally

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found in a plant. In addition, many industrialized countries make extensive use of the variety of crop plants to boost agricultural productivity. "Residents of industrialized countries are not likely to notice the effects of declines in plant diversity so immediately as in developing countries, but in the long run it will limit the productivity of our agriculture, or the quality of the health care we can receive," said Tuxill.

Courtesy USDA

The effects of plant loss extend far beyond agriculture in Tuxill's report.

Tuxill's first and foremost solution: "We must learn how to grow our food and harvest raw materials (timber, minerals, etc.) in ways that maintain biodiversity rather than degrade it."

In the last section of the report, Tuxill discusses the need to figure out how to breed — and grow and use — crops in ways that keep them genetically diverse. "I do not intend to give the impression that I am against all genetic engineering. Rather, I think that we should proceed slowly and carefully in implementing it, as with any new technology," he said.

Tuxill notes that governments, non-government organizations, and citizen activists are developing innovative partnerships to bring plant diversity back to the landscapes.

Among the examples he points to are:

- Innovative plant breeders in developing countries are working directly with farmers in participatory breeding programs to evaluate, select and improve locally adapted crop varieties while maintaining robust levels of genetic diversity.
- Consumers can buy timber products from nearly 10 million hectares of forest worldwide certified as being managed in an environmentally responsible manner under the guidelines of organizations like the Forest Stewardship Council.
- In Belize, the government has established a rain forest reserve that is being managed by a local association of traditional healers for the production of wild medicinal plants.
- In the U.S. state of Iowa , a farmers' group and university researchers are identifying agronomic practices, such as alternative crop rotations and cover crop plantings that can enhance biological diversity on farms and save farmers money on fertilizers and agrochemical inputs.

"The bottom line is that we have to share both the economic benefits of plant diversity and the obligation for protecting it," said Tuxill. "Those who garner the benefits of plant diversity, such as agribusiness and pharmaceutical consumers, should acknowledge and support those who maintain it, like indigenous cultures and national gene banks."

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- Underwater War is Raging in the Coral Reefs of Indonesia - May 02, 2001
- "Forgive and Forget" Won't Fix Third World Debt - April 26, 2001
- Earth Day Forecast: Cloudy and Hot - April 20, 2001
- Bush POPs Announcement a Relative "No-Brainer" - April 20, 2001
- The World can't Wait for Another Climate Treaty - March 28, 2001
- Lester Brown to Launch New Venture - March 21, 2001
- Ground-Breaking Toxics Report Will Wake-Up America - March 21, 2001
- Bush Makes Mistake on CO2 - March 14, 2001
- Gridiron Shouldn't Leave California in the Dark - March 09, 2001

- How Now, Mad Cow? - March 08, 2001
- Environmental Organizations Call Daimler's Unimog a "Daimlersaurus" - February 22, 2001
- We Need a New Kind of Revolution, Says Gorbachev - February 20, 2001
- Global Environment Reaches New Crossroads - January 13, 2001

2000

- The Hidden Freshwater Crisis - December 09, 2000
- Stepping Off the Toxic Treadmill - November 19, 2000
- Worldwatch Institute Names New President - October 19, 2000
- The Real Price of Oil - September 28, 2000
- Saving the Environment: A Jobs Engine for the 21st Century - September 21, 2000
- Agribusiness Concentration, Not Low Prices, is Behind Global Farm Crisis - September 01, 2000
- 20th Century Power System Incompatible with Digital Economy - July 15, 2000
- Deciphering Amphibian Decline: New Approach to Science Needed - July 01, 2000
- Social and Economic Inequities Impeding Global Environmental Action - May 27, 2000
- Worldwatch Restructures Management Team To Strengthen Its Leadership Role - April 27, 2000
- Globalization Straining Planet's Health - March 25, 2000
- Melting of Earth's Ice Cover Reaches New High - March 06, 2000
- Chronic Hunger and Obesity Epidemic Eroding Global Progress - March 04, 2000
- "Earth Day Report Card" - March 01, 2000

- Portrait Of An Industry In Trouble - February 17, 2000
- Chronic Hunger and Obesity Epidemic Eroding Global Progress - February 04, 2000
- "Information Economy Boom Obscuring Earth's Decline" - January 15, 2000

1999

- "Cutting the Costs of Paper: Saving Forests, Water, Energy ... and Money" - December 11, 1999
- The United States and China: The Soybean Connection - November 09, 1999
- Environmental Trade Skirmishes Demonstrate Need for WTO Reform - November 02, 1999
- WTO Confrontation Shows Growing Power of Activist Groups - October 27, 1999
- HIV Epidemic Slowing Population Growth as World Approaches 6 Billion - September 28, 1999
- Population Outrunning Water Supply as World Hits 6 Billion - September 23, 1999
- Plant Losses Threaten Future Food Supplies and Health Care - September 16, 1999
- Unemployment Climbing As World Approaches 6 Billion - September 02, 1999
- Drought Foreshadows Larger Water Threat - August 26, 1999
- Phasing Out Coal Environmental Concerns, Subsidy Cuts Fuel Global Decline - August 25, 1999
- India Reaching 1 Billion on August 15: No Celebration Planned - August 13, 1999
- World Carbon Emissions Fall - July 27, 1999
- Worldwatch News Release "Emerging Water Shortages" - July 17, 1999
- Winning or Losing The Environmental Battle: Cities Hold the Key to Planetary

Health - June 19, 1999

- Mbeki's Challenge: The HIV Epidemic Consuming South Africa - June 07, 1999
- Worldwatch News Release "Trends Jumping Off the Charts" - May 29, 1999
- Kosovo and Beyond: Peacemaking in a Post-Cold War World - April 29, 1999
- Our Demographically Divided World: Rising Mortality Joins Falling Fertility To Slow Population Growth - April 08, 1999
- Destructive Storms Drive Insurance Losses Up Will Taxpayers Have to Bail Out Insurance Industry? - March 25, 1999
- Turning the Tide to Save Oceans: Citizens and Governments Build New Alliances - March 20, 1999
- Nuclear Power Nears Peak - March 04, 1999
- World May be on Edge of Environmental Revolution - February 25, 1999
- Eradicating Polio: A Model for International Cooperation - January 25, 1999
- New Century to be Marked by Growing Threats, Opportunities - January 16, 1999

1998

- Wind Power Sets New Record in 1998: Fastest Growing Energy Source - December 29, 1998
- Worldwatch Wind Power Briefing Graph and Data Table - December 29, 1998
- From Grassroots to Boardrooms: Slashing Raw Material Use to Increase Profits and Protect the Environment - December 17, 1998
- Merger Signals Beginning of Geriatric Era for Oil Indistry - December 03, 1998
- Record Year for Weather-Related Disasters - November 27, 1998
- Buenos Aires Post-Mortem - November 18,

1998

- Climate Protocol Survives -- Barely - November 13, 1998
- Global Temperature Jumps Off Chart - October 29, 1998
- Kyoto Protocol Faces Crucial Test in Buenos Aires - October 20, 1998
- Worldwide Strategy Proposed to Slow Global Warming - October 14, 1998
- Global Economy Spreading Destructive Species: The Invisible Threat of Bioinvasion - October 10, 1998
- Worldwatch Briefing: Sixteen Dimensions of the Population Problem - September 24, 1998
- Worldwatch Proposes $2,000 Tax Cut Per Family to Save the Environment - September 12, 1998
- Cities Turning to Bicycles to Cut Costs, Pollution, and Crime - August 26, 1998
- Worldwatch Briefing On The Yangtze Flood - August 13, 1998
- Solar Power Markets Boom - July 16, 1998
- United States Leads World Meat Stampede - July 02, 1998
- Hidden Forces Mask Crisis in World Fisheries - June 18, 1998
- Mammals, Fish, Birds, Amphibians, Reptiles Suffering Major Declines - May 21, 1998
- Indonesia's Discontent - May 16, 1998
- Vital Signs 1998 Worldwatch Press Release - May 07, 1998
- China's Water Shortage Could Shake World Grain Markets - April 22, 1998
- Accelerating Demand for Land Wood, and Paper Pushing World's Forests to the Brink - April 04, 1998
- Report Calls for Rapid Scaling Up of Efforts to Preserve Health of Forests and Provide Economic Benefits - April 02, 1998

- Future of Global Environment Hinges on Surging Flows of Private Capital - February 28, 1998
- Building a New Economy: The Challenge for Our Generation - January 10, 1998

1997

- Kyoto Agreement Could Be Boon to Global Climate and World Economy - November 20, 1997
- Small Arms Proliferation--The Next Disarmament Challenge - October 25, 1997
- Half of all Primate Species Face Extinction - August 28, 1997
- Rising Grain Proces May Disrupt Global Economic Progress - August 16, 1997
- Recycling Organic Waste: A Win-Win Proposition - August 02, 1997
- Governments Failing to Protect Societies from Spreading Water Scarcity - June 03, 1997
- Vital Signs 1997: A Year of Disturbing Contrasts - May 24, 1997
- Shifting Tax Burden to Polluters Could Cut Taxes on Wages and Profits by 15 Percent - May 08, 1997
- Massive International Flows of Private Capital now Shaping World Environmental Future - April 23, 1997
- Food Security Deteriorating in the Nineties--Grain Prices More Volatile - March 06, 1997
- Damage to Nature Now Causing Widespread "Natural" Disasters, Economic Hardship - February 11, 1997
- State of the World 1997: A Worldwatch Institute Report on Progress Toward a Sustainable Society - January 11, 1997

1996

- Environmentally Destructive Subsidies Cost World's Taxpayers and Consumers More Than $500 Billion a Year - December 05, 1996
- Facing Reality at the World Food Summit - November 01, 1996
- New Threats to Human Security Study Documents Causes of "e;New World Disorder"e; - October 24, 1996
- Farmers and Fishers Now Need Help From Family Planner to Balance Food and Population - September 26, 1996
- Water Conflicts Loom as Supplies Tighten; Food Security Threatened, Ecosystems in Decline - September 12, 1996
- China's Claims on Earth's Resources Overtaking Those of the United States - August 28, 1996
- Wind Power Fastest Growing Energy Source Ready to Displace Coal, Slow Climate Change - August 14, 1996
- Cropland Losses Threaten World World Food Supplies - July 27, 1996
- Pressure on Climate Negotiatiors Heats Up - June 22, 1996
- VITAL SIGNS 1996: WORLD GROWING HOTTER AND HUNGRIER - May 18, 1996
- WORLDWATCH INSTITUTE URGES WORLD BANK AND FAO TO OVERHAUL MISLEADING FOOD SUPPLY PROJECTIONS - May 01, 1996
- INFECTIOUS DISEASES SURGE: ENVIRONMENTAL DESTRUCTION, POVERTY TO BLAME - April 20, 1996
- WORLD LIVESTOCK AND POULTRY INDUSTRIES FACING CUTBACKS AS U.S. CORN RUNS LOW - April 04, 1996
- DEVELOPMENT AFFECTING RIVERS AND WETLANDS BOOMERANGS TO CAUSE ECONOMIC AND BIOLOGICAL

LOSS - March 23, 1996

- Worldwatch Vital Signs Brief 96-1 - January 25, 1996

1995

- WORLDWIDE REPRESSION OF PEACEFUL ENVIRONMENTAL PROTESTORS SPURS NEW COALITIONS WITH HUMAN RIGHTS ACTIVISTS - December 09, 1995

1990

- ECONOMIC CONVERSION CRUCIAL TO CLAIMING PEACE DIVIDEND - July 16, 1990
- Apartheid Devastating South African Environment - May 12, 1990
- Air Pollution Now Threatening Health Worldwide - January 20, 1990

1989

- Water Scarcities, Irrigation Setbacks Threaten Food Supplies - December 09, 1989
- Global Poverty Up, A Result of Debt and Environmental Decline - November 18, 1989

The Heritage Seed Library (HSL) aims to conserve and make available vegetable varieties that are not widely available. The HSL Department maintains a collection, mainly of European varieties. Over the decades many varieties have been dropped from popular seed catalogues. Our collection contains many of these but also some landraces and a large number of family heirloom varieties that have never been in a catalogue. We are not a gene bank and all our collection, once we have enough seed will become available to our members.

>> Find out how to join the Heritage Seed Library and/or HDRA.

Currently we have around 700 accessions of open-pollinated varieties, of which about 200 are in our current Seed Catalogue which is sent free to members each year. Members receive their choice of up to six varieties and there is also an informal Seed Swap section run between members themselves. An extremely important and highly valued contribution to our work is made by volunteer Seed Guardians. Seed Guardians are members who have decided to take on the extra responsibility of growing seed for us. Of the 40,000 plus packets of seed sent out each year, 40-50% is supplied by Guardians. So these people are essential to maintaining a sufficient amount of stock as well as safeguarding rare varieties.

See the list of varieties being grown this year Why not Adopt a Veg?

Useful Links

As well as the Catalogue, produced in December, members also receive a newsletter (Seed News) in the spring, summer, and autumn. This covers a wide range of topics, from historical, to news items and growing tips. It also contains a letters page, and a Lost & Found section, where members can try to trace lost loves (of the vegetable kind).

Read a year in the life of HSL and Cressida's HSL Photo Diary New

We are always actively seeking to increase the amount of accessions we hold and between 1997 and 2000 a project called the Seed Search was carried out. This was funded by the DETR and aimed to seek out and save regional, family, and historic varieties which had been saved over many generations.

Read about volunteering to help us

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Future Foods
Luckleigh Cottage
Hockworthy
Wellington
Somerset TA21 0NN

future foods

rooted in the past

Home News Catalogue Gallery Information Glossary Greenhouse e-mail

Future Foods is a small independent mail order supplier specialising in rare and unusual edible plants. *Please note that we are a seed company only - we do not supply produce.*

What we offer is seeds of fruits & greens, roots & tubers, salads & herbs. Unlike most other seed companies, we also offer fungi (as inoculated logs and as spore) and fermentation starter cultures, as well as a few horticultural sundries — labels, seed boxes and so on to help our customers get the most from our products. We can easily mail to all countries within the EU, and to other countries too, but for that we do need to charge a little more to cover postage. Note that at the present time we are unable to process credit or debit card payment.

We send out 2 catalogues each year:

Our Spring catalogue is sent out in winter and into spring and includes mostly seed-grown crops — salads, greens, roots & fruits. It represents our main listing of hardy and half-hardy edible plants.

The Autumn supplement includes subjects which need to be autumn sown for them to stratify for better germination — trees and shrubs for instance — and dormant roots and tubers of those plants which are propagated this way. We take orders for these last items through the winter to then dispatch at a time appropriate for them to be planted, to ensure maximum success.

You can view our catalogue through these pages, but if you wish to be regularly posted with our latest catalogues (which are easier to read on the train, in the loo, or in the potting shed) then send us 4 x 1st Class stamps with your name and address and we'll keep you on our database for the next two copies. This means that, even if you do not order the first year, you will still remain on our database and be kept informed the next season.

A lot of what we offer is probably not familiar to everyone, which is why we provide some information sheets. We have given quite a bit of detail but if you want to know more, read Growing Unusual Vegetables by our proprietor and unusual veg guru, Simon Hickmott, published by eco-logic books. Simon is also available to give talks to garden clubs and societies, or indeed any other interested parties in the UK.

Getting in touch

Our telephone number is 01398 361 347. We try to be on the end of the phone if we can, but if the weather's dry we are likely to be working in the nursery and so not always able to take your call. So if we are not there please excuse the answer phone, leave a message and we will try to return your call. Note that we no longer operate a fax machine. Of course, you can always e-mail

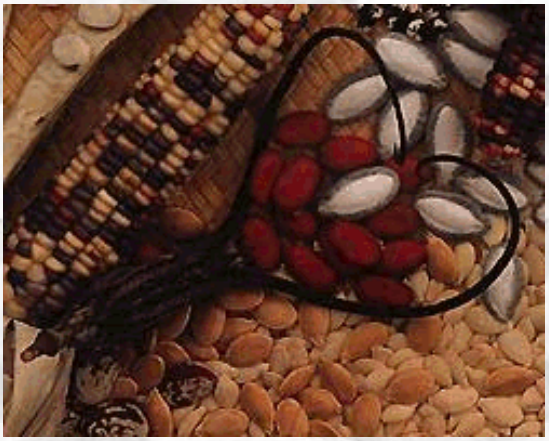
us.

Open Day

It will soon be our **Open Day**. More information about that here.

Please note that we are not the US food product company of Sonoma CA. They are here

Home | Catalogue | News | Information sheets | Picture Gallery | Growing Unusual Vegetables | Greenhouse | e-mail us



Seedsaving and Seedsavers' Resources

Click on the icons below to get to the different sections.

- NEW!! I have recently found out that it is possible to find heirloom seeds and unusual varieties on Ebay, the internet auction house. Click on the link to see what some sellers I have bought from have on offer. They might just have what you are looking for.

- NEW!! Terre de Semences in association with Association Kokopelli offer a whopping 1400 varieties of certified organic seed. Their astonishing catalogue describes all of these varities, contains colour pictures of many varieties and a lot of background information. It is worth every penny. Also please see their Manifesto for Survival for background information on the company. In 2001/2 all seed packets cost £1.50 Sterling.

Web Site Contents:

Heirloom and OP varieties: Saving Plant Genetic Resources	**Botany, Genetics and Horticulture for Seedsavers**
Trading seeds: Seed Exchanges on and off the Web	**Buying heirloom and OP seeds: Non-profit organisations**
Buying heirloom and OP seeds: Commercial sources	**Buying organic seeds**
NGOs and GOs concerned with Plant Genetic Diversity	**Books for Seedsavers**
Supplies for Seedsavers	**Miscellaneous**

Saving Plant Genetic Resources - Why?

"Seeds are critical to our success as gardeners and farmers. They are compact packages of genetic information and stored food reserves, just waiting for the conditions found in warm, moist soil in order to germinate and create tomatoes, carrots, beans and thousands of other delights out of sunshine, air, water and soil. For most of the last ten thousand years of human history, seed-saving was something nearly everyone practiced, because in order to eat and therefore to survive, it was necessary. The grains and beans which formed the basis of most diets were both seed and food. Grown in large quantities, the best were saved for planting and the rest were eaten. Our ancestors did this each year, generation after generation through the centuries. Variations in climate, soil and techniques from garden to garden and community to community, accumulated through the years, creating the incredible diversity which existed over much of our planet well into this century. These local seeds were integral to life and culture everywhere. Unfortunately, the vast majority of these varieties has disappeared."
From Bill Duesing - Living on the Earth ©1999

"Plant Genetic Resources for Food and Agriculture (PGRFA) are the biological basis of world food security and, directly or indirectly, support the livelihoods of every person on Earth."
FAO ©1999

Read about 'Recent policy trends and developments related to the conservation, use and development of genetic resources' and on 'Intellectual Property Rights and Plant Genetic Resources' as published by the International Plant Genetic Resources Institute.

- For a discussion of current issues in the seed trade, see http://www.gardeners.com/actionupdates.html

Jeremy Cherfas of Future Foods publishes the magazine LeafLET on-line. 'Everything not permitted is forbidden' outlines how EU legislation has led to tremendous losses of agricultural/horticultural biodiversity.

Read Amy Knutson's excellent article "Why Grow Open-Pollinated or Heirloom Plants?"

For the German speaker here's a similar article "Verbotene Früchte", based on a visit to an heirloom garden in northern Germany, an article on organic seed "Das Brot von morgen" and an interesting article on the legendary Vavilov Institute in Russia where a number of scientists starved to death while guarding samples of grain varieties in the institute's seed bank during the German siege of Leningrad in WWII.

- The Genetic Resources Action International (GRAIN) is an international non-governmental organisation, established in 1990, to help further a global movement of popular action against one of the world's most pervasive threats to world food and livelihood security: genetic erosion. The loss of biological diversity, particularly in the "gene rich" countries of the Third World, undermines the very sense of sustainable agriculture as it destroys choices for the future and robs people of a key resource base for survival. Genetic erosion is more than just the loss of genes. It is the loss of of options for development. GRAIN is registered in Spain as an international, non-profit foundation. It has offices in Barcelona and in Los Baños, the Philippines. A wholly autonomous organisation, GRAIN is financed by grants from NGOs, governments and intergovernmental organisations. GRAIN's programme of work is currently implemented by a team of eight people, representing different nationalities and experiences. The organisation is governed by a Board composed of dedicated individuals - scientists, grassroots field workers, development NGOs and policy makers - acting in their personal capacity. The GRAIN website also comes in a *Versión en español* and a *Version française*. GRAIN's newsletter "Seedling" can be accessed through the website. GRAIN also publishes the irregular e-mail newsletter BIO-IPR. Its purpose is to circulate information about recent developments in the field of intellectual property rights related to biodiversity & associated knowledge. BIO-IPR is a strictly non-commercial and educational service for nonprofit organisations and individuals active in the struggle against IPRs on life.
- Information on and insights into the world seed industry can be found at World Seed info. The site covers international laws, conferences, issues relating to IPR (Intellectual Property Rights), seed trade and certification, biodiversity, biotechnology, statistics, publications and Internet links.

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Botany, Genetics and Horticulture for Seedsavers

- In order to ensure varietal purity and to avoid inbreeding depression when saving seed one needs to have some idea of botany and genetics. See this excellent practical guide on Genetics for Seedsavers for details. The same website by Tom Clothier has loads of information on seed germination, taxonomy, seed viability, seed trading etc. on this page. A short "FAQ Regarding Seeds" is provided by Travis Saling. Also check out the books section on this site.
- Aleta Anderson of the Abundant Life Seed Foundation writes on varietal isolation and Kent Whealy of Seed Savers Exchange talks about Rescuing Traditional Food Crops.
- Click on the link for another good site on saving, storing and growing seed.
- A short introduction to saving seed by J.E. Ells of Colorado State University Cooperative Extension (vegetable crop specialist).
- Cathy Czapla's Saving Seeds for Home Gardeners
- How to save true Pepper Seed
- The Official Seed Starting Home Page (Flowers, vegetables, herbs).
- For the professional: The Electronic Seed Storage Behaviour (ESSB) Compendium (5MB! file for download) published by the International Plant Genetic Resources Institute
- Ben Watson wrote an excellent article on the subject of open-pollinated and hybrid varieties including a non-technical explanation of cross-pollination issues for National Gardening.
- The Canadian internet gardening resource site I Can Garden includes a good collection of seed-related articles.
- Discuss seed-saving with other gardeners, farmers and growers. Join Lawrence London's seed-saving mailing list.
- To sign up to the Heirloom Gardening Mailing List click on the link or discuss heirloom varieties on the GardenWeb Heirloom Plants and Gardens Forum.
- In order to save them you have to grow them: The Oregon State University has an excellent guide to commercial vegetable cultivation which is also useful to the smaller grower. Furthermore, there is a very long list of vegetable seed suppliers in the US and a link to Seed Quest, an information service for seed professionals which contains listings of seed companies by crop. Another good site on vegetable crops and their production is the course outline "Hort 410 - Vegetable Production" published by Purdue University, Indiana, USA.
- Where did agriculture originate and when? Where did our major crops originate? How were plants modified as a consequence of cultivation? The University of California provides an on-line tutorial on the "Evolution of Crop Plants" free for personal use. Other courses deal with the "Conservation of Plant Genetic Resources" and "Plant Breeding" but appear not to be online.
- A useful meta-resource is the Internet Directory for Botany Part of this Directory is the huge link collection on Economic Botany and Ethnobotany with links on crops, ethnobotany, herbal medicine, plant pathology, poisons, and weeds.
- The Crop Index of the Center for New Crops and Plant Products of Purdue University, Indiana, USA provides a very comprehensive list of scientific and common names of crops giving access to crop profiles and scientific articles on crops of all sorts. Don't be put off by the name 'new' as virtually everything including many old neglected and unusual crops are included. Click on the link for the New Crop Resource Online Program.
- Search the very informative and easy to use Plants for a Future Database for information on over 7000 species of edible and other useful plants.
- Another useful meta-resource on crop plants it the Multilingual Multiscript Plant Name Database On-line Bibliographical Resources

NEW!!
- The California Rare Fruit Growers, Inc. maintain a database of 250 rare and unusual edible plants as well as Fruit List, a listing of fruit cultural data, arranged by scientific name, containing temperature limits and information on soil conditions for over 700 individual fruits. There is also a listing of over 1,000 fruits by their common names. CRFG also run a seed bank (members only) and publish a magazine.

- The Germplasm Resources Information Network (GRIN) web server provides germplasm information about plants, animals, microbes and invertebrates within the National Genetic Resources Program of the U.S.

Department of Agriculture's (USDA) Agricultural Research Service (ARS). Grin taxonomic data provide the structure and nomenclature for the accessions of the National Plant Germplasm System (NPGS). Many plants (35,000 taxa, 13,000 genera) are included in GRIN taxonomy, especially economic plants. See: World Economic Plants in GRIN.

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Trading seeds: Seed Exchanges on and off the Web

Mailing lists

- Dave M. Ford's Seed Exchange Mailing List: "The purpose of the Seed Exchange Network is to allow those of us who garden as a hobby to find and exchange seeds that we either want or have excess of." To subscribe send a blank email with the word SUBSCRIBE in the subject line to seeds@bigfoot.com.
- Links and Usegroups

Bulletin Boards on the Web

- Zaxie Seed Traders - a place where you can trade seeds with other gardeners from all over the world for free. Also contains a template for seed envelopes and lots of gardening info.
- Garden Exchanges and Trading and Swapping
- Seed Swap Club at Seedman.com. Click on *"Click here to see list of members"* to access the listings.
- Algy's Herb Seed Exchange
- US Seed Exchange
- US Plant Exchange
- Canadian Garden Exchange
- Australian Garden Exchange
- Europe's Garden Exchange.
- Asle & Magnar's Seed Exchange Forum with a focus on alpines and perennials. Norway
- 'FireGirl's' Seed Exchange Bulletin Board
- Bernie's Seed and Tip Exchange
- GardensDFW Seed Exchange Bulletin Board
- HomeArts Seed Swap, a swap page from the publishers of Good Housekeeping and Country Living magazines.
- Karen's Organic Garden (Arizona) 'Garden swap-meet'
- + only. National Gardening Magazine Seed Swap Forum
- The Canadian internet gardening resource site I Can Garden has a Seed Sharers/Seed Savers forum
- The Ethnobotany Cafe Herb Exchange Classifieds (Huge!)
- Permaculture Seed and Plant Exchange. Attn: Joe Hollis, Mountain Gardens, 3020 White Oak creek Rd., Burnsville, NC 28714 USA - Katuah Bioregion. -- specializes in useful self-seeding and perennial species. ($7/Yr.) Now online?
- (TX) Seeds of Texas Seed Exchange, a non-profit, membership-based seed trading organization which welcomes the participation of all gardeners and native plant collectors (one needn't offer seeds in the Exchange to be eligible to join, but you must be a member to order seeds through the Exchange).

Private individuals offering exchanges on their own websites

- @man's Seed Swap/Seed Trade/Seed Exchange - huge list, all organically grown.
- Tom Clothier's Seed Trading List - mostly annual and perennial flowers; links to lots of photographs. Illinois. Gary Cowan's seed exchange and urban gardening site. Oklahoma.
- Iril Kolles Seed swap list - Flowers, some herbs. Norway
- "Zaratrusta Undergound" Seed Exchange in Spain. The name says it all.
- Cindy McDee's Heirloom Tomatoes
- Seed Trading List - mostly flowers.
- Bjoern Malkmus provides information on swapping and ordering seeds and plants,including many species from the Canary Islands, Spain and other rare and unusual tropicals/hardy plants/bulbs.
- Cathy Czapla's Seeds to Share, flowers and vegetables, hand-collected from own small organic garden or, if wildflowers, from nearby fields.

Exchanges off the WWW

- (MI) Home Grown Exchange, 16428 Woodstock, Macomb, MI 48044 -- Membership $12/year --monthly issues of a newsletter which includes articles and letters from seed savers as well as a seed exchange listing; send $2 for a sample copy or a send a listing of seeds you will offer for exchange and get a free copy.
- The Irish Seed Savers Association is a voluntary organisation dedicated to the location and preservation of traditional varieties of fruit and vegetables. The ISSA maintains a seed bank which distributes seeds of non-commercially available vegetables, including heritage potatoes. They have put together an incredible collection of more than 120 old Irish apple varieties which were first offered for sale (grafted to order) in 1999, and they are running a Heritage Grain Project (24 varieties) in Co. Wexford.
- The Flower & Herb Exchange, 3076 North Winn Road, Decorah IA 52101; Phone 319-382-5990; Fax 319-382-5872 Membership is $10 in the US, $12 in Canada and Mexico, $15 other international.

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Buying heirloom and open-pollinated seeds: Non-profit organisations

- The Henry Doubleday Research Association HDRA, Britain's Premier organic gardening organisation, maintains the Heritage Seed Library of endangered vegetables containing over 700 varieties of interesting and traditional vegetables that can't legally be traded in Europe. These seeds cannot be purchased but Members of the Library can receive free seed packets each year.
- Projekt LAV, A-8385 Mühlgraben 46. They had an impressive list of heirloom varieties and unusual edibles and other useful plants in 1998. Don't seem to be online at present. The seeds cannot be legally traded in Europe. LAV is asking for modesty, reimbursement of postage and, if possible, a small donation to the project.
- Pro Specie Rara is a Swiss NGO, founded in 1982, which aims at preserving as many agricultural/horticultural plant varieties and domestic animal breeds as possible. They have five part-time employees who co-ordinate projects with the bulk of the actual preservation work carried out by more than 1000 private volunteers. Finance is practically raised entirely from private donations. Pro Specie Rara is constanty looking for custodians of plant varieties. Contact them at Pro Specie Rara-Sekretariat, Engelgasse 12a, CH-9000 St.Gallen, Switzerland, Fax +41-71-223 74 01. Their website contains a 'Variety finder' searchable database "Sortenfinder" for vegetables, grains, fruit (with pictures of apple varieties).
- Seeds of Diversity Canada - Canada's Heritage Seed-Saving Network, a non-profit group of gardeners from coast to coast who save seeds from rare and unusual garden plants for the purpose of preserving the varieties - a living gene bank.
- (OR) Abundant Life Seed Foundation is a non-profit organisation dedicated to the preservation of genetic diversity. They acquire, preserve and distribute open-pollinated seeds, with an emphasis on heirloom vegetables, medicinal herbs, and Pacific NW natives. They also provide education on cultivation and seedsaving and run the World Seed Fund which uses donations to send out seeds to struggling farmers in

South America, to urban garden projects, schools and rehabilitation projects. The project will purchase a 101 acre site in California, the Horse Creek Farm, in November 1999 in order to create a working, sustainable seed farm. For contributions and detailed information, please contact the Horse Creek Seed Sanctuary.

- (NJ) Garden State Heirloom Seed Society (GSHSS): see the entry below
- (IA) Seed Saver's Exchange 3076 N. Winn Rd. Decorah, IA 52101 (319)382-5990 fax (319)382-5872 free; publishes a Garden Seed Inventory periodically which contains information on substantially all heirloom/OP varieties of vegetables offered in North America over the past 15 years or so, including all known seed houses still offering them. They also have a Fruit, Nut and Berry inventory that covers those classes of edibles. The Garden Seed Inventory is invaluable for determining if a variety is OP or not and if so, where to find it. The latest edition consists of 803+ pages of the names and describtions of open-pollinated plants. It also lists commercial sources in both the US and Canada. The softcover edition is $26 plus $3 shipping to US addresses. Shipping overseas is c. $9. A hardcover edition is available too for $32.
- High Altitude Gardens with the ISSI - International Seed Saving Institute
- The Eastern Native Seed Conservancy concerned with saving especially the varieties native to this country. They have a participant growers program where you can grow a certain variety and send them the seeds to help in their efforts.

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Buying heirloom and OP seeds: Commercial sources

- Heirloom Seed Sources
- Brown University's Heirloom Seed Directory
- TheSeedGuild - Seed businesses
- Another list of seed sources.
- Seed Company Listing compiled by The Heirloom Gardening Page
- uk.rec.gardening Suppliers and References Faq
- Chase Organics (Great Britain) Ltd
- Thomas Etty Esq Heritage Seedsman and Bulb Merchant
- SandemanSeeds
- The Seed Search Third Editon + Seeds + Horticulture + Plants + Gardening + Gardens + Directory
- Breckland Service 2
- FYI, Chase Organics, Suffolk Herbs, Kings Seeds & Tamar (& no doubt others) are all in fact supplied by Kings Of Kelvedon, seems the only difference is in packaging, marketing strategies & prices!!! (eg, Suffolk Herbs have a nice high production value, colour catalogue with tasteful water colours of the plants, etc- Tamar are far more basic & so are their prices). Suffolk Herbs are now owned by Kings - Kings are a major supplier to the UK seed market, however there are others, Thomas Etty, for instance also gets seeds from French and Italian suppliers.
- DT Brown in the UK: An old established company enjoying an impressive revival with an excellent choice of modern and traditional varieties. Their Heritage range includes many heirloom varieties incluing striped zinnias, striped French marigolds, dark-leaved nasturtiums and other varieties usually unavailable elsewhere. Their vegetable range is also one of the best in the UK, with some modern F1 hybrid vegetables as well as heirlooms like the pink and white flowered 'Painted Lady' climbing bean. The catalogue includes plants and seedlings which cannot be sent overseas. DT Brown also publish an excellent trade catalogue, specifically aimed at smaller commercial growers.
- --> Ordering British Seed from the USA: A number of British seed companies will supply seed to gardeners in the USA. American gardeners will find varieties of seed raised plants in British mail order seed catalogues which are not available in the USA; some will be heirloom varieties which have been kept going in Europe or recently reintroduced, others will be new varieties which have not yet been listed in American catalogues.
- Mr Fothergill's Seeds: One of Britain's newer seed companies but one which lists many unusual varieties in its two seed catalogues, the general catalogue and the enthusiasts' catalogue. Both catalogues include a number of excellent nineteenth century heirlooms, as well as modern varieties in single colours where most companies offer only mixtures. Webpage?
- Chiltern Seeds specialises in annuals and bedding plants in separate colours along with many unusual

botanical items ranging from cacti and palms to trees and vines. E-mail only.

- Seeds-by-Size sells vegetables, herbs and flowers, including many unusual annuals and many single colours reputedly available to home gardeners from no other company - anywhere in the world.
- Thompson & Morgan offer a comprehensive list of seeds, including thousands of varieties of flowers and vegetables. Their site includes catalogues for USA and Worldwide Sales, both wholesale and retail. They also have a catalogue specialising in young plants for sale only to the United Kingdom. Their seed catalogues (available from 1st August 1999) include thousands of varieties and are fully indexed and searchable.
- Herbiseed (Weeds of the world), The Nurseries, Billingbear Park, Wokingham, Berkshire, RG40 5RY, UK. Tel : UK-01344 425586. Good source for hard to find weed and wild plant seeds.
- Nicky's Mail Order Flower Seeds Worldwide. On-line seed store for the amateur and professional gardener. Seeds for bedding plants, hanging baskets, house plants, containers, patio and rockeries. Some F1 varieties but also lots of open-pollinated varieties.
- B_and_T_World_Seeds
- Suppliers of Organic, Non-GE, or Heirloom (O-P) Vegetable Seed - Horticulture Resource List, large listing arranged by US region plus listing for Canada
- Check out the ICanGarden suppliers listing for Canada or their international listing.
- Farm Gate Seed Potatoes from Prince Edward Island
- Richters Herbs - Medicinal, Culinary, Aromatic - Plants & Seeds
- (BC) The Virtual Gardener Inc. Heirloom Seed Collection.
- (ON) Aimers Seeds Botanical Seed Catalogue
- The Oregon State Univeristy keeps a list of vegetable seed suppliers in the US and a link to Seed Quest, an information service for seed professionals which contains listings of seed companies by crop.
- Another list of seed suppliers in the US can be found here.
- Southern Exposure Seed Exchange Home Page Although they emphasize varieties adapted to the Mid-Atlantic region, they serve gardeners throughout the United States and Canada. A large percentage of the seed and bulb varieties they offer are grown by themselves or their growers. They are family-owned and operated. Much of their seed is organically grown. All their seed is free of chemical treatment and they do not offer genetically engineered varieties. They grow at least 40% of their own seed and offer over 550 varieties of open-pollinated, heirloom, and traditional varieties of vegetables, flowers, and herbs; large selection of garlic cultivars and rare perennial onions. Also included are books, gardening supplies, and seed-saving supplies and information.
- (CA) Bountiful Gardens: Vegetables, herbs, grains and green manure seeds, all open-pollinated and untreated.
- (ID) High Altitude Gardens, a bio-regional seed company selling varieties adapted to cold, short seasons. All are tested in their gardens at 6,000 ft. 180 varieties of open-pollinated, untreated vegetable seeds. Some organic seed. Also wildflowers, herbs, grasses.
- (ID) Seeds Blüm, HC33, Idaho City Stage Boise, ID 83706. Catalogue $3. Specialise in heirloom, open-pollinated seeds.
- (OH) Down on the Farm Seed, PO Box 184, Hiram, OH 44234
- Just Sunflowers
- Seeds for US Gardens
- Old House Gardens - Heirloom Flower Bulbs. Scott Kunst of OHG also provides a "Source List for Historic Ornamentals" in the US (send SASE and $1 to OHG, 536 Third St., Ann Arbor, MI 48103-4957, USA).
- (OR) Victory Seeds. Over 140 open-pollinated or heirloom vegetable and herb seed varieties.
- "http://www.olympus.net/insidepassage/">Inside Passage - specialty seed service, featuring native and naturalized flora of the coastal Cascadian Bioregion (Northwestern North America) and also offering relevant publications and consulting services.
- (VT) The Cook's Garden (Vermont)

- (SC) Park Seed Company (South Carolina)
- (AZ) Simpson's Heritage Seed (Arizona)
- (CA) Grandview Tomatoe Farms (heirloom and open pollinated varieties) 12942 Dupont Rd. Sebastopol, CA 95472 free list, may also send Irish Eyes with a Hint of Garlic potatoes@irish-eyes.com POB 307 Ellensburg WA 98926 (509)925-6025 fax (509)925-9238 free; garlic, potatoes, onions and other tubers with lots of planting info sample seeds
- (CA) J.L. Hudson, Seedsman Ethnobotanical Catalogue of Seeds Star Route 2, Box 337 La Honda CA 94020 $1.00 Quirky, but dedicated and knowedgeable to a fault. Incredibly detailed listing.
- (CA) Santa Barbara Heirloom Seedling Nursery
- (ME) Fedco POB 520 Waterville, ME 04903 (207) 873-7333 fax (203)872-8317 free, Best prices, generous packets, volume discounts, free shipping. Besides, they quote Walt Whitman throughout, what better endorsement do you need?
- (AZ) Native Seeds/SEARCH nss@azstarnet.com 526 N 4th Ave Tuscon AZ 85705 $1.00 Fascinating reading, tribal info., rare seeds, Desert Foods for Diabetes Control, tepary beans, sorghums. or http://www.desert.net/seeds/home.htm preserves southwestern Native American seeds.
- (OR) Oregon Exotics 1065 Messinger Rd. Grants Pass OR 97527 (541)846-7578 $4.00 Wapato, chinese yam, water chestnuts...
- (IA) Sand Hill Preservation Center 1878 230th St Calamus IA 52729-9659 319-246-2299 (business hours) - specializing in heirloom open-pollinated seeds, sweet potato slips and rare poultry breeds. This is an excellent source of op corn, squash and tomatoes. They personally grow out over 2,000 varieties of heirlooms; family run.
- (MO) Baker Creek Heirloom Seeds sell only open-pollinated varieties with an emphasis on heirlooms (seeds and plants, the latter only within the US). Their small but informative catalogue includes a book list and other useful info. Contact Jeremiath C. Gettle for a catalogue or check their website.
- (ME) Johnny's Selected Seeds, Foss Hill Rd. Albion, ME 04910-9731; Free catalog.
- (FL) Tomato Growers Supply, P.O. Box 2237, Ft. Myers, FL 33902.
- (GA) Flowery Branch Seed Company PO Box 1330 Flowery Branch, GA 30542 Phone: (770) 536-8380 - Flowery Branch Seed Company in Flowery Branch, Georgia is a superb source of seed for those of us who are addicted to growing old-fashioned and uncommon flowering garden plants. don't concentrate exclusively in heirlooms they list almost no F1 hybrid bedding plants.
- (CA) Redwood City Seed Company. P.O. Box 361 Redwood City, CA 94064
- (ME) Pinetree Seeds Box 300, New Gloucester, ME 04260; Free catalog.
- Burpee Seeds and Plants Special section on heirloom vegetables and flowers. Cannot ship any orders outside the continental U.S.
- (ME) Wood Prairie Farm: Seed potatoes; Tel. US (800) 829-9765 Albion, ME 04910-9731. Free catalogue.
- (HI) Fruit Lovers Nursery offers rare tropcal fruit seed. Oscar Jaitt, PO Box 1597, Pahoa, HI 96778. Telephone and Fax (808)965-9785 in Hawaii
- (VA) Burford Brothers (Antique Apples & Other Fruit), Route 1, Monroe, VA 24574; $2 for catalog.
- (TX) Antique Rose Emporium, 9300 Lueckenmeyer Rd., Brenham, TX 77833-6453, (800) 441-0002; Catalogue is $5, which is deductable from first order.
- (OR) Heirloom Old Garden Roses, 24062 N.E. Riverside Dr., St. Paul, OR 97137, Catalogue is $5.
- (CA) World Seed (flower seeds, vegetables seeds, herbs seeds, gardening)
- (OR) Virtual Seeds: extensive on-line seed catalog, including heirloom varieties and a search engine that lets you look for plant varieties on the Web by plant name! Postal catalogue available as well.
- (WA) The Rock Garden, small listing of mostly vegetables and herbs (all open-pollinated).
- (MA) GardenMakers - The Seed Source, specializes in unusual and hard-to-find flower seed. Their selection features alpines, woodland plants, ornamental grasses and primulas.
- (PA) The Bethlehem Seed Company specializes in colorful varieties that can be used to accent an edible landscaping design (vegetables, flowers and herbs).

- (MN) Matthew's Old Time Seed List: Pre-20th Century & Traditional Vegetables.
- (MS) Seedman.com - Exotic Plant and Garden Seed Catalog. Retail and wholesale. Special section on Heirloom/Open Pollinated Garden Vegetable Seeds. Free Seed Swap Club. Click on "click here to see list of members" to access the listings.
- Millenium Seeds: Non-hybrid vegetables, fruit and herbs.
- (NM) Seeds Unique 1125 Barboa Ct., Belen, New Mexico 87002, USA. Flowers, vegetables, trees, decorative plants, cacti.
- (PA) Heirloom Seeds: old-time vegetable, flower and herb seeds (all seeds are non-hybrid). P. O. Box 245 W. Elizabeth PA 15088-0245. Catalogue $1.
- Bliss Partnership: 28 O'Connell Street, Tamworth, 2340, Australia.
- Phoenix Seeds: Mail order; they have a catalogue of about 500 varities; while some are hybrid they are clearly identified as such. Phone: 61362679663 P.O. Box 207, SNUG 7054, Tasmania, Australia. E-mail only - no webpage
- The Global Plants and Seeds Emporium
- Heirloom varieties from Garden.com
- Backyard Biodiversity (links don't work at present (30 August 1999)

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Buying organic seeds

- The Irish Organic Trust has compiled an inventory of suppliers of certified organic seed (Europe & USA).
- Chase Organics (Great Britain) Ltd. Despite the name only a small (but growing) section of the seed Chase is selling is actually certified organic. All of the organic varieties I have tried (lettuces, radishes, onions) have grown exceptionally well here in the West of Ireland, where Chase's seeds are sold by Deelish Garden Centre, Skibberreen, Co. Cork.
- NEW!! Terre de Semences in association with Association Kokopelli offer a whopping 1400 varieties of certified organic seed. Their astonishing catalogue describes all of these varities, contains colour pictures of many varieties and a lot of background information. It is worth every penny. Also please see their Manifesto for Survival for background information on the company. In 2001/2 all seed packets cost £1.50 Sterling.
- The Henry Doubleday Research Association HDRA, Britain's Premier organic gardening organisation, maintains the Heritage Seed Library of endangered vegetables containing over 700 varieties of interesting and traditional vegetables that can't legally be traded in Europe. These seeds cannot be purchased but Members of the Library can receive free seed packets each year.
- DT Brown in the UK sell an expanding range of organic vegetable seed (Soil Association Organic Standard).
- Future Foods: Weird and wonderful things for the edible garden. Future Foods is a small, independent supplier of edible plants in Wedmore / Summerset. They are dedicated to back-garden biodiversity, seeking out old and forgotten varieties while at the same time looking for new things for the edible garden. Future Foods is *not certified* organic. Only some of their seeds are certified, but most are grown in accordance with organic principles.
- Graines Baumaux offer a small seletion of certified organic vegetables seed for the first time in 1999.
- Bio-Saatgut
- Biologisches Saatgut Check Marketplace, Seed. The link contains 2 Excel files for downloading, one for vegetable/herbs and one for grain, potatoes etc. Sources are given for each crop.
- Allerleirauh GmbH, Saatguthandel, Kronstraße 24, D-61209 Echzell, Tel 06035-81216, Fax 81275. Germany
- Dreschflegel, Föckinghauser Weg 9, D-49324 Melle, Tel 05422-8994, Fax 8764. Germany
- Ferme de Sainte Marthe, c/o Ulla Grall, Bäreneck 4 / Efeuhaus, D- 55288 Armsheim, Tel 06734-960379, Fax 960014. Germany. Beautiful catalogue with lots of rare and forgotten vegetable varities

with a particularly large assortment of tomatoes and cucurbits (pumkins, squash etc). Some herbs and flowers. All certified organic. NEW!! Website online since late January 2000.

- Ferme de Sainte Marthe, BP 10, 41700 Cour-cheverny, France. Certifié Agriculture Biologique.
- Ferme de Sainte Marthe, St Marthe PO Box 358 Walton, Surrey KT12 4YX. (Tel: 01932 266630.) A seed catalogue which supplies organic seeds of rare and forgotten vegetable varieties.
- Terry Klokleid of Amblewood Organic Farm in British Columbia sells organic vegetable and herb seeds and seedlings.
- (BC) Aurora Biodynamic Farm 3492 Phillips Road, Creston, BC V0B 1G2, 250-428-4404. A family run business located on 31 acres in the heart of the Kootenay River Valley in southeastern British Columbia. All seeds are open-pollinated (non-hybrid), untreated and grown in accordance with biodynamic farming principles.
- The Natural Gardening Company is a certified organic nursery in the US selling vegetable, herb and flower seeds as well as beneficial insects, drip irrigation, composting equipment, tools and wildflower seeds.
- (OR) Sow Organic Seed Co. sell a good range of vegetable, herb and flower seeds, including many heirloom varieties - all grown on their own farm. Certified by the "Oregon Tilth Certified" programme and recognized by the States of Oregon and California.
- (PA) Pepper Joe's 100% organic hot peppers
- (NM) Seeds of Change P.O. Box 15700, Santa Fe, NM 001-888-762-7333 toll-free; Free catalog. More than 1500 varieties plus bulbs and perennials. Currently ship only w/i US and Canada. Certified by the "Oregon Tilth Certified" programme. Great website!
- Pure Seed Company (organic seed potatoes)
- (OR) Horizon Herbs Strictly Medicinal POB 69 Williams OR 97544 Tel. US (541)846-6704, Fax (541)846-6233 Catalogue $2.00. A family run business, and more delightful folks than most! A bible of herb information. Herb seeds and live roots, certified organically grown or wild-harvested.
- (OR) Nichols Garden Nursery, 1190 N. Pacific Hwy., Albany, OR 97321-4598.
- (OR) Territorial Seed Company (Oregon) Another good source for organic, open-pollinated seeds, including heirloom and/or traditional varieties. There is an on-line catalog that includes tools and supplies, and somewhat of a focus on varieties adapted to the general Pacific Nortwest (USA/Canada) climate.
- (OH) Companion Plants complants@frognet.net; 7247 N. Coolville Ridge Rd. Athens OH 45701 (740)592-4643 fax (740)593-3092; $3.00 or free list chinese artichokes, ashwaganda, tobaccos, amaranths, sweet grass, golden seal, jerusalem artichoke,comfrey...
- CA Peaceful Valley Farm & Garden Supply POB 2209 Grass Valley, CA 95945 (530)272-4769 free
- Thyme Garden Web-Site
- (WA) Ronniger's Seed Potaotes, a small and family run business, offers an incredible selection of potatoes as well as some other tubers/bulbs like sunchokes, onions, and garlic along with some books and tools. They are known for excellent service. Organic, disease free, etc. They also encourage growers to save their own seed potatoes from year to year if you grow in disease-free soil. Their address is now Ronniger's Seed Potatoes PO Box 1838 18705 188th Street East Orting, WA 98360, 360-893-8782 , 360-893-3492 Fax.
- (MI) Southmeadow Fruit Gardens, Box SM, Lakeside, MI 49116 (616) 469-2865 Offering scores of historic fruit varieties, particularly apples.
- Greenpatch Organic Seeds: P.O. Box 1285, Taree, NSW 2430, Australia.
- Eden Seeds: Mail order and catalogue from, "Eden Seeds, M.S. 316, 21a Sandy Creek Road Gympie, Queensland, 4570, Australia. They only sell organic, non hybrid traditional, open pollinated seeds. Free call in Australia Phone and fax, 1800 188 199.

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NGOs and GOs concerned with Plant Genetic Diversity

- NEW!! The Save Foundation (Safeguard for Agricultural Varieties in Europe) acts as European umbrella organization for the promotion and coordination of activities for the conservation of endangered breeds of domestic animals and cultivated plant varieties in the form of live populations. Collection and dissemination of information as well as coordination and support of national activities are the main focuses. In various countries, national organizations must still be established or expanded. Additionally. enormous tasks present

themselves in Eastern and Southeastern Europe where agriculture is experiencing a radical restructuring. Conservation projects are realized primarly on farm.

- The Genetic Resources Action International (GRAIN) publishes the irregular e-mail newsletter BIO-IPR. Its purpose is to circulate information about recent developments in the field of intellectual property rights related to biodiversity & associated knowledge. BIO-IPR is a strictly non-commercial and educational service for nonprofit organisations and individuals active in the struggle against IPRs on life.
- CGIAR and its System-Wide Information Network for Genetic Resources
- Detailed information on the FAO's work on Plant Genetic Resources for Food and Agriculture can be found here. FAO have assembled 154 Country Reports on Plant Genetic Resources which provide information on indigenous plant genetic resources and related conservation and utilization activities, including reviews of the agricultural systems of each country.
- DG6 EU - Directorate General (Agriculture) of the European Union
- Directory of Community legislation in force: Seeds and seedlings; also available in all other official EU languages.
- DG VI - Standing Committee on seeds and propagating material for agriculture, horticulture and forestry pdf files of minutes of committee meetings (Acrobat Reader required).
- DG VI activities:Genetic resources in agriculture - The site provides information on Regulation (EC) No 1467/94 on the conservation, the characterization, the collection and the utilization of genetic resources in agriculture.
- International Plant Genetic Resources Institute - European Section. See also their downloadable information resources on policy, PGR, IPR, genebanks, genetics etc.
  The *Plant Genetic Resources Newsletter* from IPGRI, Issue #118, pp. 38-50 contains an article titled *"Internationally available information sources for the development of in situ conservation strategies for wild species useful for food an agriculture"*, which lists 50+ URLs (including detailed descriptions).
- The Baden-Württemberg section of the German Nature Conservancy (NABU-Naturschutzbund Deutschland) is currently running the "Projekt Kulturpflanzenvielfalt" (Crop Plant Diversity Project), March 1999 - March 2000, an interesting initiative supported by the EU Commission, with partners in Germany, Austria, Switzerland, the Netherlands, Sweden and Finland. There are still a number of events and workshops during September as well upcoming national and international conferences. The website is also available in English.
- Resource pages of the Information Centre for Genetic Resources IGR, also available in German
- European Working Group on Research and Biodiversity
- Baltic Cooperation on Plant Genetic Resources and Nordic Gene Bank
- Vavilov Institute of Plant Industry in Russia
- The UK Agricultural Biodiversity Coalition (UKabc) an activity of the UK Food Group. Bringing together Public Interest UK organisations concerned with Sustainable Use, Conservation, Benefit Sharing, Trade, Patents, Intellectual Property, Biopiracy, Biotechnology, Genetic Engineering, Biosafety and other issues related to the Equitable Use of Agricultural Biodiversity for Local Food and Livelihood Security.
- The Henry Doubleday Research Association HDRA, Britain's Premier organic gardening organisation, maintains the Heritage Seed Library of endangered vegetables containing over 700 varieties of interesting and traditional vegetables that can't legally be traded in Europe. Many are family heirlooms nurtured from generation to generation; others were once commercial varieties, now no longer offered by seed companies, the seeds being victims of commercial pressures and draconian European rules. Members of the library are able to receive up to seven packets of free seed each year. These seeds cannot be purchased but Members of the Library can receive free seed packets each year.
- UK Plant Genetic Resources Group
- The Irish Seed Savers Association is a voluntary organisation dedicated to the location and preservation of traditional varieties of fruit and vegetables. The ISSA maintains a seed bank which distributes seeds of non-commercially available vegetables, including heritage potatoes. They have also put together an incredible collection of more than 120 old Irish apple varieties, many of which had been considered lost, and

they are running a Heritage Grain Project (24 varieties) in Co. Wexford. Their work is supported by the Irish Heritage Council and Irish universities. Click here for some photographs taken during a visit in October 1999.

- The Irish Genetic Resources Conservation Trust aims to conserve both wild and domesticated plant and animal genetic resources in Ireland.
- NGOs in Germany active in the field of in situ and on farm conservation.
- VEN - Verein zur Erhaltung der Nutzpflanzenvielfalt e.V.; c/o Ursula Reinhard, Sandbachstrasse 5, D-38162 Schandelah (work predominantly within Germany).
- Pro Specie Rara is a Swiss NGO, founded in 1982, which aims at preserving as many agricultural/horticultural plant varieties and domestic animal breeds as possible. They have five part-time employees who co-ordinate projects with the bulk of the actual preservation work carried out by more than 1000 private volunteers. Finance is almost entirely raised from private donations. Pro Specie Rara is constanty looking for custodians of plant varieties. Contact them at Pro Specie Rara-Sekretariat, Engelgasse 12a, CH-9000 St.Gallen, Switzerland, Fax +41-71-223 74 01. Their website contains a 'Variety finder' searchable database "Sortenfinder" for vegetables, grains, fruit (with pictures of apple varieties).
- Centre for Genetic Resources in the Netherlands. Maintains the Dutch genebank for plant genetic resources for food and agriculture. CGN is also involved in in situ/on-farm conservation programmes. CGN supplies seeds of the crops in its collections to any bona fide user anywhere in the world (most users are plantbreeders or scientists).
- Austrian Genebanks for Crop Plants
- Arche Noah (Gesellschaft zur Erhaltung und Verbreitung der Kulturpflanzenvielfalt), Obere Straße 40, A-3553 Schiltern (projects not just in Austria but also elsewhere in Europe, showgarden in Schiltern).
- National Seed Storage Laboratory (NSSL) - Mai.
- Rural Advancement Foundation International (RAFI) is an international non-governmental organization headquartered in Winnipeg, Manitoba (Canada) with affiliate offices in Pittsboro, North Carolina (USA). RAFI is dedicated to the conservation and sustainable improvement of agricultural biodiversity, and to the socially responsible development of technologies useful to rural societies. RAFI is concerned about the loss of genetic diversity - especially in agriculture - and about the impact of intellectual property rights on agriculture and world food security.
- The Farmer Cooperative Genome Project (FCGPATM1L1) is a collaborative effort to return farmers and gardeners to the practices of characterizing and saving seed. With support from the Fund for Rural America, and administered by Oregon Tilth, the FCGP explores the feasibility of a cooperative marketing structure that rewards producers for maintaining the nation's most vital resource base - the seed. The Farmer Cooperative Genome Project is a three year project to assemble a farmer owned seed cooperative. Participants in the effort will learn how to work with the United States* repository of seeds (the National Plant Germplasm System) and other seed resources, learn how to characterize or describe varieties, learn how to grow true seeds, and develop plant varieties for preservation and sale. For more information contact: JJ Haapala at Oregon Tilth.
- International Seed Saving Institute (ISSI), a nonprofit organization dedicated to seed saving. ISSI, with the support of its members and Seeds Trust, hopes to teach one million Americans and others around the world how to save seeds; and by forming a seed bank, help safeguard the world's decreasing gene pool of open pollinated varieties.
- United Plant Savers - a non-profit organization whose mission is "...to protect native medicinal plants of the United States and Canada and their native habitat while ensuring an abundant renewable supply of medicinal plants for generations to come." There's a newsletter, an "at risk" plants list, an events calendar, networking opportunities, and information on UPS' first "botanical sanctuary" (in Rutland, Ohio, USA), including an internship program available there.
- (NJ) Garden State Heirloom Seed Society (GSHSS) P.O. Box 15, Delaware, NJ 07833, Tel: USA 908-475-4861 Attn: Joseph or Roberta Cavanaugh.
  Membership dues were $10 for 1999. They publish a booklet of articles and news and the seed listings each year. They concentrate on the heirlooms of NJ but accept others as well. If you're interested in tomatoes, this is the place to go, as one member alone has grown out 2,000 varieties. Most seed is obtained from the individual listers, unless a variety is only offered by GSHSS. Members listing seeds pay half of those not listing. Seed generally has to be requested by May 15th or so each year. They also sponser a tomatoe tasting event each year as well as 1 or 2 other programs, mostly in Northern NJ. They also have an ongoing project to reprint old seed catalogs.
- Heirloom Seed Project, Landis Valley Museum, 2451 Kissel, Hill Rd. Lancaster, PA 17601 717-569-0401.

- Seedsavers.org - Saving Crop Plant Diversity exists as a means for seed saving producers to find markets, and for consumers of seed saving to find sources. Some of the current and projected facilities of Seedsavers.org are free, and some, to support the ongoing work, are provided for a fee.
- The Seedsavers Network - Australian seedsaving group. They publish a handbook on growing traditional varieties of food plants, run regular seedsaving workshops and are involved in a number of overseas projects in Zimbabwe, Cambodia, Tonga, Cuba and on the Solomon Islands.
- The Heritage Seed Curators Australia save seeds from unusual and rare species. Also see their Why Save Seed? general and legal info.
- The Heritage Fruits Group aims to find, document and conserve old varieties of fruit trees in southeast Australia.
- The Seed Science and Technology Division, Department of Agronomy, UPLB, College, Laguna, Philippines, helps to promote and develop the local seed industry using the sustainable agriculture framework through seed education, research and extension.
- In a small village in Uttar Pradesh is a collection of native Indian seeds that would put even a genebank to shame. Vijay Jardhari, a farmer in Chamba in the Garhwal Himalaya has a rare collection of traditional seed varieties which he maintains by cultivating in small plots of land. There is an urgent need to promote more such seed banks writes Indira Khurana at http://www.oneworld.org/cse/html/dtedte981231/dte_grass.htm.
- The Solomon Islands Planting Materials Network has for the past four years worked directly with rural communities, development aid agencies and government agricultural research and extension organisations to make available the non-hybrid seed of food crops used by village subsistence farmers and has achieved recognition for its pioneering work throughout the South Pacific as well as in Australia.
- Programme for Plant Genetic Resources in Southern Africa: SADC
- Maize Genetics Co-operation Stock Centre
- The Maize Page of the Iowa State University, College of Agriculture. A Resource for Students, Producers and Specialists.

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Books for Seedsavers

- Ashworth, Suzanne. Seed to Seed (ISBN 0-9613977-7-2) published in 1991. Seed Saver Publications, RR 3 Box 239, Decorah, Iowa 52101, 1991 (my own No. 1 reference book). Also available from the Abundant Life Foundation. The German Language edition is called *Saatgutgewinnung im Hausgarten*.
- The Seed Savers Handbook, Grover Books, available from Ecologic Books, 19 maple grove, Bath, BA2 3AF or from the Seedsavers Network. A complete reference for growing, preparing and conserving traditional varieties of food plants. It was written especially for Australian and New Zealand conditions in 1993 by Michel and Jude Fanton, founders of The Seed Savers' Network.
- Seeds of Texas' Vegetable Seed-Savers Handbook offers a concise, complete introduction to safely and reliably growing, saving, harvesting and storing your own vegetable seeds. Some of the content is available on-line.
- Seeds of Diversity Canada, formerly "Heritage Seed Program" produced an illustrated booklet (33 pages) that describes how to save your own vegetable seeds. It starts out with the general principles of seed saving, and then gives specific instructions on how to save seeds from each different type of vegetable. An insert with the text translated into French is available.
- A New Book from Seeds of Change GARDENING FOR THE FUTURE OF THE EARTH - Changing the World from Your Backyard available from Bantam, New Year 2000.
- Turner, Carole B.: Seed Sowing and Saving, published at $28.95, is available for $7.24 from Gardener's Book Club at www.booksonline.com/gbc
- Deppe, Carol (1993): Breed Your Own Vegetable Varieties: Popbeans, purple peas, and other innovations from the backyard garden. Little, Brown and Co. Publishers, 303 pp. $18.95 -- layman's guide to breeding techniques and strategies.
- Bubel, Nancy (1988): The New Seed-Starters Handbook. Rodale Press, 385 pp, $15.95 (more in Canada). -- general text for seed-starting techniques for starting a variety of vegetables, fruits, trees, grains, herbs, etc. Includes 65-page section on seed-saving.
- Weaver, William Woys: Heirloom Vegetable Gardening - A Master Gardener's Guide to Planting, Seed

Saving and Cultural History . Henry Holt & Co. $45

- Gardner, Jo Ann: The Heirloom Garden. Storey Books, Tel. US 800-441-5700. $16.95
- Starting from Seed by Brooklyn Botanic Garden, Tel. US 718-622-4433, ext. 274. $9.95
- Male, Carolyn (1999): 100 Heirloom Tomatoes for the American Garden. "Over the past 10 years, Male has grown and evaluated more than 1,200 heirloom varieties and offered seeds through the Seed Savers Exchange. She says the best of the heirlooms far exceed hybrids when it comes to taste. In her book, just published by Workman, Male writes short histories and descriptions of 100 of her favorites. The accompanying color photographs, by Frank Ionanotti, are positively voluptuous." (Diane White, Boston Globe, August 30, 1999)
- Dirr, Michael & Heuser, Charles (1987): The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture- A practical working guide to the propagation of over 1100 species, varieties and cultivars. Varsity Press, Athens, GA. 239 pgs.-- guide to woody ornamental propagation, including seed handling, treatments, etc.
- Cutler, Karan Davis (1998): Starting from Seed: The Natural Gardener's Guide to Propagating Plants, Handbook #157, Brooklyn Botanic Garden., 111 pp - according to one reviewer excellent intro to seed saving, more on the Why's than the Hows and great photos!
- Ausubel, Kenny: Seeds of Change: The living treasure
- Nabhan, Gary Paul (1989): Enduring Seeds: Native American Agriculture and Wild Plant Conservation, North Point Press, San Francisco.
- Raeburn, Paul: The last harvest: The genetic gamble that threatens to destroy American Agriculture
- CAB International, a not-for-profit organization providing services worldwide to agriculture, forestry, human health and the management of natural resources publish a range of interesting scientific books, including
  - R.E. Evenson, D. Gollin and V. Santaniello (1998) Agricultural Values of Plant Genetic Resources
  - D Wood and J M Lenné (eds.) (1999): Agrobiodiversity: Characterization, Utilization and Management.
  - Guarino, LL Guarino, Rao, RV Ramanatha Rao and RR Reid (eds.)(1995): Collecting Plant Genetic Diversity: Technical Guidelines
  - J A Callow, B V Ford-Lloyd and H J Newbury (eds.) (1997): Biotechnology and Plant Genetic Resources: Conservation and Use
  - R A T George (1999): Vegetable Seed Production, 2nd Edition, R A T George: former senior lecturer, University of Bath, UK and consultant to UN/FAO, Italy
  - R Pistorius and J van Wijk (1999): The Exploitation of Plant Genetic Information: Political Strategies
  - Elizabeth Cromwell (1996): Governments, Farmers and Seeds in a Changing Africa
  - D B Egli (1998): Seed Biology and the Yield of Grain Crops
- Any book or article by Jeremy Rifkin.
- Shiva, Vandana (1991): Biodiversity, Biotechnology and Profits - in Vandana Shiva et al. Biodiversity: Social and Ecological Perspectives. London. Zed Books Ltd., pp. 43-58.
- Shiva, Vandana (1994): The Seed and the Earth: Biotechnology and the Colonization of Regeneration - in Vandana Shiva, ed. Close to Home: Women Reconnect Ecology, Health and Development Worldwide. Gabriola Island, BC: New Society Publishers
- Bountiful Gardens: Ecology Action Books and Publications
- Fertile Ground Books - Farming, Agriculture, Plant Book Specialists (new and used) have a special section for books on seed production etc. which lists some of the titles above.
- The Redwood City Seed Company contains a gardening books & brochures section with some items of interest to seedsavers.

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Supplies for Seedsavers

- The Catalog & Growing Guide from Southern Exposure Seed Exchange lists a number of seed saving supplies.

Miscellaneous

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The following websites have linked to this site:

- Plants for a Future - The excellent resource and information centre for edible and other useful plants
- Cathy Czapla's Saving Seeds for Home Gardeners in the US and her Basic Guide to Saving Seeds for Home Gardeners FAQ
- Larry London's InterGarden, a huge site with everything you ever wanted to know about sustainable farming, organic gardening, permaculture, bioregionalism, homesteading. Highly recommended!
- UK Agricultural Biodiversity Coalition: Agricultural Biodiversity - Sustainable Use for Food Security
- Graham Leatherbarrow's Gardening Site in the UK
- John Schinnerer's Food Resources: (food production systems, permaculture, soil, seeds, processing, information resources)
- Seedsavers.org - Saving Crop Plant Diversity
- The Nursery - (UK gardening site + plant database)
- The Purdue University New Crop Resource Online Program
- The Heritage Seed Curators Australia
- The Cucurbit Network Links
- Gary Cowan's Urban Gardening Site
- The Multilingual Multiscript Plant Name Database On-line Bibliographical Resources

Seeds on Ebay

The items listed in the table below are from sellers located in the UK.

Find seeds in other countries

For questions, comments, suggestions for additions, notification of 'dead' links etc. please contact Ute Bohnsack, creator and 'webmistress' of this page, via e-mail.

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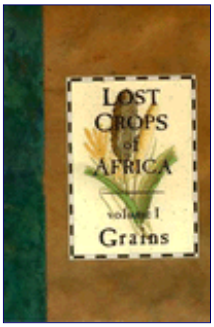

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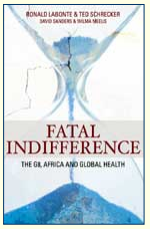

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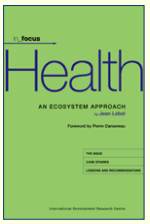

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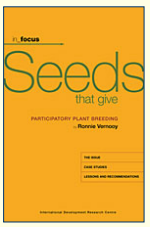

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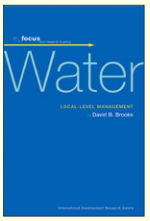

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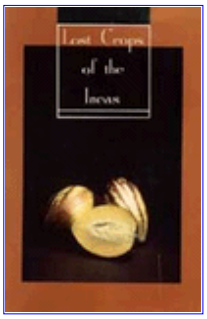

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Lost Crops of the Incas: Little-Known Plants of the Andes with Promise for Worldwide Cultivation

Ad Hoc Panel of the Advisory Committee on Technology Innovation, Board on Science and Technology for International Development, National Research Council

428 pages, 6 x 9, 1989, ISBN

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Description

This fascinating, readable volume is filled with enticing, detailed information about more than 30 different Incan crops that promise to follow the potato's lead and become important contributors to the world's food supply. Some of these overlooked foods offer special advantages for developing nations, such as high nutritional quality and excellent yields. Many are adaptable to areas of the United States.
Lost Crops of the Incas includes vivid color photographs of many of the crops and describes the authors' experiences in growing, tasting, and preparing them in different ways. This book is for the gourmet and gourmand alike, as well as gardeners, botanists, farmers, and agricultural specialists in developing countries.

Review

". . . [will] inspire those with an interest in agriculture and an entrepreneurial spirit to experiment with these obscure plants of the Inca Empire." --*The New York Times Book Review*

"This is a most readable book, containing much information which is not available in other publications." --*Outlook on Agriculture*
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Farmers Seed Production

New approaches and practices

Conny Almekinders and Niels Louwaars.

Published Price: £15.95
ISBN: 1853394661
Published By: ITDG Publishing
Published Date: 1999
Format: Paperback
Category: Agriculture-Seeds

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Description

"This handbook covers a whole range of issues relating to local seed supply systems, including participatory plant breeding, and both technical and practical information on seed production and variety maintenance. It suggests new approaches and methods to support on-farm seed production by small-scale farmers in developing countries. The first part of the book describes the functioning of local seed systems and discusses their strengths, limitations and possibilities for improvement. The authors discuss in detail issues of genetic diversity and in-situ conservation, farmers rights and legislation. The cases presented here illustrate the functioning of local seed systems and experiences with improving them. The second part contains technical information on seed production, selection, storage and distribution, and varietal maintenance and improvement of different groups of important food crops, which can be applied and implemented at the level of small-scale farming. The third part contains practical guidelines about how on researchers and agriculturalists might carry out surveys to investigate local seed systems and their limitations, and how they can involve interested farmers in practical experimentation to improve their crop seed. This book will be of great value and interest to people who work directly with farmers, including extension agents, national and international NGOs, and farmerscooperative workers."

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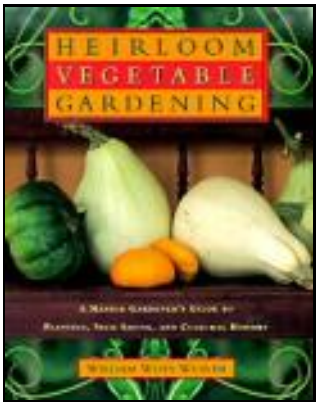

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Heirloom vegetable gardening ;a master gardener's guide to planting, seed saving, and cultural history

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ISBN: 0805040250 Subtitle: a master gardener's guide to planting, growing, seed saving, and cultural history Foreword: Hatch, Peter J. Publisher: Henry Holt and Company Subject: Vegetables Subject: Vegetable gardening Edition Number: 1st ed. Series Volume: 4 Publication Date: 1997 Binding: Trade Cloth Language: English Illustrations: Yes Pages: xxii, 439 p. Dimensions: 9.56x7.78x1.53 in. 2.20 lbs.

Other customers have also purchased:

- Lost Crops of Africa: Volume 1: Grains (Lost Crops of Africa Vol. I) by National Research Council
- Golden Bough by James G Frazer

Synopses & Reviews

Publisher Comments:

This book is the culmination of some thirty years of firsthand knowledge of growing, tasting, and cooking with heirloom vegetables. A staunch supporter of organic gardening techniques, Will Weaver has grown every one of the featured 280 varieties of vegetables, and he walks the novice gardener through the basics of planting, growing, and seed saving. Sprinkled throughout the gardening advice are old fashioned recipes - such as Parsnip Cake,

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Artichoke Pie, Pepper Wine, and Henry Ward Beecher's Favorite Turtle Bean Soup - that highlight the flavor of these vegetables. This is the first comprehensive garden book on this subject that also includes meticulous research on the origins and dates of introduction for most of the varieties discussed, as well as fascinating stories and lore about the vegetables. It is illustrated with over one hundred color photographs taken in the author's garden and with over two hundred line drawings and includes a listing of commercial seed and plant stock sources.*

Description:
Includes bibliographical references (p. [395]-409) and index.

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Ten reasons why biotechnology will not ensure food security, protect the environment and reduce poverty in the developing world

Miguel A. Altieri, University of California, Berkeley and Peter Rosset, Food First/Institute for Food and Development Policy, Oakland, California
October 1999

This article appeared in: *Sierra Magazine*
(Also available en español)

Biotechnology companies often claim that genetically modified organisms (GMOs) -- specifically genetically altered seeds -- are essential scientific breakthroughs needed to feed the world, protect the environment, and reduce poverty in developing countries. This view rests on two critical assumptions, both of which we question. The first is that hunger is due to a gap between food production and human population density or growth rate. The second is that genetic engineering is the only or best way to increase agricultural production and thus meet future food needs.

Our objective is to challenge the notion of biotechnology as a magic bullet solution to all of agriculture's ills, by clarifying misconceptions concerning these underlying assumptions.

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1. There is no relationship between the prevalence of hunger in a given country and its population. For every densely populated and hungry nation like Bangladesh or Haiti, there is a sparsely populated and hungry nation like Brazil and Indonesia. The world today produces more food per inhabitant than ever before. Enough is available to provide 4.3 pounds every person everyday: 2.5 pounds of grain, beans and nuts, about a pound of meat, milk and eggs and another of fruits and vegetables. The real causes of hunger are poverty, inequality and lack of access. Too many people are too poor to buy the food that is available (but often poorly distributed) or lack the land and resources to grow it themselves (Lappe, Collins and Rosset l998).

2. Most innovations in agricultural biotechnology have been profit-driven rather than need-driven. The real thrust of the genetic engineering industry is not to make third world agriculture more productive, but rather to generate profits (Busch et al l990). This is illustrated by reviewing the principle technologies on the market today: a) herbicide resistant crops such as Monsanto's "Roundup Ready"soybeans, seeds that are tolerant to Monsanto's herbicide Roundup, and b)"Bt" crops which are engineered to produce their own insecticide. In the first instance, the goal is to win a greater herbicide market-share for a proprietary product and in the second to boost seed sales at the cost of damaging the usefulness of a key pest management product (the Bacillus thuringiensis based microbial insecticide) relied upon by many farmers, including most organic farmers, as a powerful alternative to insecticides. These technologies respond to the need of biotechnology companies to intensify farmers' dependence upon seeds protected by so-called" intellectual property rights," which conflict directly with the age-old rights of farmers to reproduce, share or store seeds (Hobbelink l991). Whenever possible corporations will require farmers to buy company's brand of inputs and will forbid farmers from keeping or selling seed. By controlling germplasm from seed to sale, and by forcing farmers to pay inflated prices for seed-chemical packages, companies are determined to extract the most profit from their investment (Krimsky and Wrubel l996).

3. The integration of the seed and chemical industries appears destined to accelerate increases in per acre expenditures for seeds plus chemicals, delivering significantly lower returns to growers. Companies developing herbicide tolerant crops are trying to shift as much per acre cost as possible from the

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herbicide onto the seed via seed costs and/or technology charges. Increasingly price reductions for herbicides will be limited to growers purchasing technology packages. In Illinois, the adoption of herbicide resistant crops makes for the most expensive soybean seed-plus-weed management system in modern history -between $40.00 and $60.00 per acre depending on rates, weed pressure, etc. Three years ago, the average seed-plus-weed control costs on Illinois farms was $26 per acre, and represented 23% of variable costs; today they represent 35-40% (Benbrook l999). Many farmers are willing to pay for the simplicity and robustness of the new weed management system, but such advantages may be short-lived as ecological problems arise.

4. Recent experimental trials have shown that genetically engineered seeds do not increase the yield of crops. A recent study by the USDA Economic Research Service shows that in 1998 yields were not significantly different in engineered versus non-engineered crops in 12 of 18 crop/region combinations. In the six crop/region combinations were Bt crops or HRCs fared better, they exhibited increased yields between 5-30%. Glyphosphate tolerant cotton showed no significant yield increase in either region where it was surveyed. This was confirmed in another study examining more than 8,000 field trials, where it was found that Roundup Ready soybean seeds produced fewer bushels of soybeans than similar conventionally bred varieties (USDA l999).

5. Many scientists claim that the ingestion of genetically engineered food is harmless. Recent evidence however shows that there are potential risks of eating such foods as the new proteins produced in such foods could: act themselves as allergens or toxins, alter the metabolism of the food producing plant or animal, causing it to produce new allergens or toxins, or reduce its nutritional quality or value as in the case of herbicide resistant soybeans that contained less isoflavones, an important phytoestrogen present in soybeans, believed to protect women from a number of cancers. At present there is a situation in many developing countries importing soybean and corn from USA, Argentina and Brasil, in which genetically engineered foods are beginning to flood the markets, and no one can predict all their health effects on consumers, most unaware that they are eating such food. Because genetically engineered food remains unlabeled, consumers cannot discriminate between GE and non-GE food, and should serious health problems arise, it will be extremely difficult to trace

them to their source. Lack of labeling also helps to shield the corporations that could be potentially responsible from liability (Lappe and Bailey, l998).

6. Transgenic plants which produce their own insecticides closely follow the pesticide paradigm, which is itself rapidly failing due to pest resistance to insecticides. Instead of the failed "one pest-one chemical" model, genetic engineering emphasizes a "one pest-one gene" approach, shown over and over again in laboratory trials to fail, as pest species rapidly adapt and develop resistance to the insecticide present in the plant (Alstad and Andow l995). Not only will the new varieties fail over the short-to-medium term, despite so-called voluntary resistance management schemes (Mallet and Porter l992), but in the process may render useless the natural pesticide "Bt," which is relied upon by organic farmers and others desiring to reduce chemical dependence. Bt crops violate the basic and widely accepted principle of "integrated pest management" (IPM), which is that reliance on any single pest management technology tends to trigger shifts in pest species or the evolution of resistance through one or more mechanisms (NRC l996). In general the greater the selection pressure across time and space, the quicker and more profound the pests evolutionary response. An obvious reason for adopting this principle is that it reduces pest exposure to pesticides, retarding the evolution of resistance. But when the product is engineered into the plant itself, pest exposure leaps from minimal and occasional to massive and continuous exposure, dramatically accelerating resistance (Gould l994). Bt will rapidly become useless, both as a feature of the new seeds and as an old standby sprayed when needed by farmers that want out of the pesticide treadmill (Pimentel et al l989).

7. The global fight for market share markets is leading companies to massively deploy transgenic crops around the world (more than 30 million hectares in l998) without proper advance testing of short- or long-term impacts on human health and ecosystems. In the U.S., private sector pressure led the White House to decree "no substantial difference" between altered and normal seeds, thus evading normal FDA and EPA testing. Confidential documents made public in an on-going class action lawsuit have revealed that the FDAs own scientists do not agree with this determination. One reason is that many scientists are concerned that the large scale use of transgenic crops poses a series of environmental risks that threaten the sustainability of agriculture (Goldberg, l992; Paoletti and

Pimentel l996; Snow and Moran l997; Rissler and Mellon l996; Kendall et al l997 and Royal Society l998):

. The trend to create broad international markets for single products, is simplifying cropping systems and creating genetic uniformity in rural landscapes. History has shown that a huge area planted to a single crop variety is very vulnerable to new matching strains of pathogens or insect pests. Furthermore, the widespread use of homogeneous transgenic varieties will unavoidably lead to "genetic erosion," as the local varieties used by thousands of farmers in the developing world are replaced by the new seeds (Robinson l996).

b. The use of herbicide resistant crops undermine the possibilities of crop diversification thus reducing agrobiodiversity in time and space (Altieri l994).

c. The potential transfer through gene flow of genes from herbicide resistant crops to wild or semidomesticated relatives can lead to the creation of superweeds (Lutman l999).

d. There is potential for herbicide resistant varieties to become serious weeds in other crops (Duke l996, Holt and Le baron l990).

e. Massive use of Bt crops affects non-target organisms and ecological processes. Recent evidence shows that the Bt toxin can affect beneficial insect predators that feed on insect pests present on Bt crops (Hilbeck et al l998), and that windblown pollen from Bt crops found on natural vegetation surrounding transgenic fields can kill non-target insects such as the monarch butterfly (Losey et al l999). Moreover, Bt toxin present in crop foliage plowed under after harvest can adhere to soil colloids for up to 3 months, negatively affecting the soil invertebrate populations that break down organic matter and play other ecological roles (Donnegan et al l995 and Palm et al l996).

f. There is potential for vector recombination to generate new virulent strains of viruses, especially in transgenic plants engineered for viral resistance with viral genes. In plants containing coat protein genes, there is a possibility that such genes will be taken up by unrelated viruses infecting the plant. In such situations, the foreign gene changes the coat structure of the viruses and may

confer properties such as changed method of transmission between plants. The second potential risk is that recombination between RNA virus and a viral RNA inside the transgenic crop could produce a new pathogen leading to more severe disease problems. Some researchers have shown that recombination occurs in transgenic plants and that under certain conditions it produces a new viral strain with altered host range (Steinbrecher l996).

Ecological theory predicts that the large-scale landscape homogenization with transgenic crops will exacerbate the ecological problems already associated with monoculture agriculture. Unquestioned expansion of this technology into developing countries may not be wise or desirable. There is strength in the agricultural diversity of many of these countries, and it should not be inhibited or reduced by extensive monoculture, especially when consequences of doing so results in serious social and environmental problems (Altieri l996).

Although the ecological risks issue has received some discussion in government, international, and scientific circles, discussions have often been pursued from a narrow perspective that has downplayed the seriousness of the risks (Kendall et al. 1997; Royal Society 1998). In fact methods for risk assessment of transgenic crops are not well developed (Kjellsson and Simmsen 1994) and there is justifiable concern that current field biosafety tests tell little about potential environmental risks associated with commercial-scale production of transgenic crops. A main concern is that international pressures to gain markets and profits is resulting in companies releasing transgenic crops too fast, without proper consideration for the long-term impacts on people or the ecosystem.

8. There are many unanswered ecological questions regarding the impact of transgenic crops. Many environmental groups have argued for the creation of suitable regulation to mediate the testing and release of transgenic crops to offset environmental risks and demand a much better assessment and understanding of ecological issues associated with genetic engineering. This is crucial as many results emerging from the environmental performance of released transgenic crops suggest that in the development of "resistant crops", not only is there a need to test direct effects on the target insect or weed, but the indirect effects on the plant (i.e. growth, nutrient content, metabolic changes), soil, and non-target organisms. Unfortunately, funds for research on environmental risk

assessment are very limited. For example, the USDA spends only 1% of the funds allocated to biotechnology research on risk assessment, about $1-2 million per year. Given the current level of deployment of genetically engineered plants, such resources are not enough to even discover the "tip of the iceberg". It is a tragedy-in-the-making that so many millions of hectares have been planted without proper biosafety standards. Worldwide, such acreage expanded considerably in 1998 with transgenic cotton reaching 6.3 million acres, transgenic corn: 20.8 million acres and soybean: 36.3 million acres, helped along by marketing and distribution agreements entered into by corporations and marketers (i.e. Ciba Seeds with Growmark and Mycogen Plant Sciences with Cargill), in the absence of regulations in many developing countries. Genetic pollution, unlike oil spills, cannot be controlled by throwing a boom around it, and thus its effects are non-retrievable and may be permanent. As in the case of pesticides banned in Northern countries and applied in the South, there is no reason to assume that biotechnology corporations will assume the environmental and health costs associated with the massive use of transgenic crops in the South.

9. As the private sector has exerted more and more dominance in advancing new biotechnologies, the public sector has had to invest a growing share of its scarce resources in enhancing biotechnological capacities in public institutions including the CGIAR and in evaluating and responding to the challenges posed by incorporating private sector technologies into existing farming systems. Such funds would be much better used to expand support for ecologically based agricultural research, as all the biological problems that biotechnology aims at can be solved using agroecological approaches. The dramatic effects of rotations and intercropping on crop health and productivity, as well as of the use of biological control agents on pest regulation have been confirmed repeatedly by scientific research. The problem is that research at public institutions increasingly reflects the interests of private funders at the expense of public good research such as biological control, organic production systems and general agroecological techniques . Civil society must request for more research on alternatives to biotechnology by universities and other public organizations (Krimsky and Wrubel l996). There is also an urgent need to challenge the patent system and intellectual property rights intrinsic to the WTO which not only provide multinational corporations with the right to seize and patent genetic resources, but that will also accelerate the rate at which

market forces already encourage monocultural cropping with genetically uniform transgenic varieties. Based on history and ecological theory, it is not difficult to predict the negative impacts of such environmental simplification on the health of modern agriculture (Altieri l996).

10. Although there may be some useful applications of biotechnology (i.e. the breeding drought resistant varieties or crops resistant to weed competition),because these desirable traits are polygenic and difficult to engineer, these innovations will take at least l0 years to be ready for field use. Once available and if farmers can afford them, the contribution to yield enhancement of such varieties will be between 20-35%; the rest of yield increases must come from agricultural management. Much of the needed food can be produced by small farmers located throughout the world using agroecological technologies (Uphoff and Altieri l999). In fact, new rural development approaches and low-input technologies spearheaded by farmers and NGOs around the world are already making a significant contribution to food security at the household, national and regional levels in Africa, Asia and Latin America (Pretty l995). Yield increases are being achieved by using technological approaches , based on agroecological principles that emphasize diversity, synergy, recycling and integration; and social processes that emphasize community participation and empowerment (Rosset l999). When such features are optimized, yield enhancement and stability of production are achieved, as well as a series of ecological services such conservation of biodiversity, soil and water restoration and conservation, improved natural pest regulation mechanisms, etc (Altieri et al l998). These results are a breakthrough for achieving food security and environmental preservation in the developing world, but their potential and further spread depends on investments, policies , institutional support and attitude changes on the part of policy makers and the scientific community, especially the CGIAR who should devote much of its efforts to assist the 320 million poor farmers living in marginal environments. Failure to promote such people-centered agricultural research and development due to diversion of funds and expertise to biotechnology, will forego a historical opportunity to raise agricultural productivity in economically viable, environmentally benign and socially uplifting ways.

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Genetic Engineering

Will Biotechnology Feed the World's Poor?

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January, 1998

One of the biggest myths perpetuated by the biotechnology industry is that genetically engineered crops are likely to provide a solution to world hunger. Companies like ICI Seeds, Britain's largest seeds merchant, proclaim that biotechnology will be the most reliable and environmentally acceptable way to secure the world's food supplies .

Elsewhere, executives from the Monsanto Corporation have gone as far as to promote themselves as part of the solution to the world's food and environmental problems: 'sustainable agriculture is only possible only with biotechnology and imaginative chemistry', they claim in a 1990 article entitled 'Planetary Patriotism'. Similarly, a recent advertisement from Monsanto depicts maize growing in the desert with the caption: "Will it take a miracle to solve the worlds hunger problems?". Implicit in these messages is that to oppose biotechnology is to reject the best hope for a solution to world hunger and to perpetuate the suffering of starving children.

Despite the evidence that genetically engineered crops may provide higher yields in the short term (it remains to be seen whether they do so in the long term) there are a number of good reasons why these arguments simply do not stand up to analysis. On the contrary there is plenty of evidence to suggest that biotechnology will more than likely reduce food and livelihood security for the worlds poor. Here are six reasons why biotechnology and food security can never be compatible:

1. **Biotechnology can never be a cure for hunger - Famines are not caused by lack of food but by lack of access to food and alternative sources of income in times of crisis. There are ample reserves of food in the world today yet the numbers of malnourished run into hundreds of millions. Increasing agricultural production (even assuming that this is possible through biotechnology) whilst leaving the structural causes of poverty and hunger unaddressed is a recipe not for feeding the world but for continuing to starve sizable numbers within it.**
2. **Biotechnology creates dependency - Biotechnology goes hand in hand with intensive agriculture, with single crops in large fields. The majority of Third World farmers are small-scale, farming a variety of crops. By switching to genetically engineered seeds they have to change their practices and become dependent on the companies which provide the "package" of seeds, herbicides, fertilizers, irrigation systems, etc. In India, farmers using Monsanto's genetically engineered seeds pay an extra $50 - $65 per acre as a 'technical fee' over and above the price of seed. Farmers who do business with**

Monsanto must sign a contract stating that they will not buy chemicals from any one else.

3. **Biotech Companies can not be trusted - There is nothing in the environmental record of Corporations like DuPont or Monsanto, who are leading proponents of biotechnology, to suggest that they should be trusted now. These same companies have always promoted non-sustainable, industrial, socially inequitable agriculture. Monsanto remains one of the largest polluters in the United States. The company was responsible for 5% of the 5.7 billion pounds of toxic chemicals released in to the US environment in 1992**
4. **Biotechnology reduces diversity - Biotechnology reduces diversity by promoting certain species over others, so reducing the genetic pool even further. We are already massively over-dependent on a handful of food crop varieties. Genuine sustainable agriculture on the other hand promotes multi-cropping and companion planting as the best resistance to pests, viruses and changes in climate. Traditional varieties of subsistence food crops are often more nutritious than the high-yield varieties promoted by the agro-chemical and seed companies.**
5. **Biotechnology encourages 'Biopiracy' - Business interests and chemical companies use research into unusual genes from plant, animal and even human genes, as a means of getting control over local genetic resources - once they have manipulated that gene they reinforce control, and earn massive profits, by 'patenting'. Many developing countries were opposed to this at GATT/World Trade Organisation negotiations and continue to express concern at the way 'trade related intellectual property rights' (TRIPS) work in favour of the industrialised countries. The creation of monopoly rights to biodiversity utilisation can have serious implications for erosion of national and community rights to biodiversity and devalue indigenous knowledge systems . Sustainable food and livelihood security in the Third World is likely to be weakened rather than strengthened as a result.**
6. **The world's starving do not make good customers - What evidence is there to show that 20 years of biotechnology research, a billion dollars of expenditure and countless hours of scientific labour has benefited the world's hungry or resource poor farmers in the South? Science-based biotechnology research has so far tended to benefit the high external input agriculture of the North. Most biotech products have been aimed at consumer niche markets in the North - Calgene's $25 million 'Flavr Savr' tomatoes for example, whose only advantage over competitors is three - five days' extra shelf life. A fraction of the money that has been poured into biotechnology research could have a far greater impact if it was invested in strengthening and promoting the huge variety of sustainable and alternative agriculture possibilities that already exist in the world.**

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Genetic Engineering and World Hunger:

Food? Health? Hope?

> ***"Ensuring food security worldwide requires an approach that is the opposite of that promoted by Biotechnology companies"***

From: **The CornerHouse: Briefing No 10, October 1998***

CONTENTS

- **Denying Food To The Hungry**
- **Unsustainable Agriculture**
- **Choice? What Choice?**
- **Alternative Routes**
- **Notes and References**

Genetic engineering companies have been taken aback this year by the strength of public reaction in Europe against their recent attempts to grow and trade in genetically-engineered crops.

In response, the US company Monsanto, one of those at the forefront of these developments, launched an extraordinary public relations campaign. The most visible arm of the campaign was full-page advertisements placed week after week in British newspapers and magazines promoting the purported benefits of genetically-engineered food.

The headline across one of these adverts boldly stated that "worrying about starving future generations won't feed them. Food biotechnology will". Other PR material, destined for a European audience, maintains that slowing the acceptance of biotechnology is "a luxury our hungry world cannot afford".

The key planks of Monsanto's PR campaign are perhaps best summed up in the three words of the

newly-crafted company slogan which appeared in restrained lettering at the bottom of the advertisements: **"Food • Health • Hope"**. Genetic engineering is key to *feeding the world's increasing numbers of people*. It will help to *restore a healthy environment and prevent further degradation*. And it will provide farmers and consumers worldwide with *more choices and opportunities*.

Close analysis, however, suggests that the widespread adoption of genetic engineering in agriculture would have precisely the opposite effects.

• Far from staving off world starvation, genetic engineering is set to threaten crop yields; to force farmers to pay for their rights to fertile seed; to undercut foreign demand for some Third World produce: and to undermine poorer farmers' access to land on which to grow food. Its cruelly deceptive promise of a technical fix for many people's lack of food not only conceals the unjust distribution of land and of economic and political power which underpin world hunger today: if adopted widely, genetic engineering technologies in agriculture would also entrench and extend these forces.

• Far from relieving modern agriculture of the need to douse the soil with damaging petrochemicals, agricultural genetic engineering is tailored to reinforce farmer dependence on chemical herbicides and fertilizers. Like the Green Revolution of the 1960s and 1970s, it is guaranteed to set in train the further evolution of plants and insects resistant to the chemicals, resulting in unprecedented pest outbreaks and weed problems. At the same time, it is likely to reduce crop biodiversity still further and to trigger crop failures. Genetic engineering builds new health risks into an agricultural system already crowded with dangers for both farmers and consumers.

• Far from opening up new opportunities for farmers and consumers, a gene revolution in agriculture is part of a wider package encompassing international legislation and trade restrictions designed to tighten corporate control over food production. Instead of encouraging smallholder independence and farmer-friendly innovations in multiple cropping, non-chemical farming and agricultural diversity, companies promoting genetic engineering (and their allies in governments, trade bodies and research institutions) are working full-time - in accordance with sound business principles - to increase poor peoples' dependence on the corporate sector for seeds, agricultural inputs and produce, to restrict agricultural research to a single narrow channel compatible with corporate profit-taking, and to increase debt among those who can least afford it.

In what follows, the claims made by promoters of genetic engineering in agriculture to provide the world with food, health and hope are examined and rebutted one by one.

- **Part One, *Denying Food To The Hungry*** looks at the potential social and economic impacts of genetically-engineered crops, in particular, at how their widespread adoption is likely to deny rather than to increase poorer people's access to food;
- **Part Two, *Unsustainable Agriculture*** analyses the ecological risks of genetic engineering in agriculture and the likely impacts on agricultural output;

- **Part Three,** ***Choice? What Choice?*** details the tactics being used by companies and their allies to push farmers into growing genetically-engineered crops despite these risks; and finally
- **Part Four,** ***Alternative Routes*** outlines the case for pursuing a different path in agriculture - and the policies that might help achieve it.

PART I: DENYING FOOD TO THE HUNGRY

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"The starving are starving because they are denied access to food - not because there is not enough food"

To a public confronted with television images of the starving in Sudan and elsewhere, the claim that genetically-engineered crops will feed growing numbers of people in the Third World has great moral appeal. Its proponents seem highly responsible, even altruistic.

Yet the claim is deeply misleading. It seems plausible only if one overlooks the real causes of malnutrition, hunger, starvation and famine, and erroneously assumes that the hungry must be hungry because there is not enough food.

Responding to a British scientist's claim that those who want to ban genetically-engineered crops are undermining the position of starving people in Ethiopia, Tewolde Berhan Gebre Egziabher, Ethiopia's representative at the ongoing negotiations to draw up a biosafety protocol as part of the Convention on Biological Diversity,[1] recently stated:

"There are still hungry people in Ethiopia, but they are hungry because they have no money, no longer because there is no food to buy . . . We strongly resent the abuse of our poverty to sway the interests of the European public."[2]

While few doubt that more food will have to be grown in future if the increasing numbers of people in the world are to be adequately fed, those who starve or go hungry today (whether in Ethiopia or in the United States or in Britain) do so primarily because they are denied access to food. A whole range of unjust and inequitable political and economic structures, especially those relating to land and trade, in combination with ecological degradation, marginalise poorer people and deprive them of the means to eat. (**See Box: Increased Yields?**)

More than enough food is already being produced to provide everyone in the world with a nutritious and adequate diet[3] - according to the United Nations' World Food Programme, one-and-a-half times the amount required. Yet at least one-seventh of the world's people - some 800 million people - go hungry. About one-quarter of these are children. They starve because they do not have access to land on which to grow food, or do not have the money to buy food, or do not live in a country with a state welfare system.

Genetic engineering in agriculture will do nothing to address these underlying structural causes of hunger. On the contrary, it is likely to do much to exacerbate them. Few of the foods currently

being researched and developed are foods which the hungry can afford. Moreover, the high costs of genetically-engineered crops are likely to squeeze many small and medium-sized farmers out of business, with the result that still more people will be unable to grow or pay for the food they need. And, far from diminishing the adverse impacts of modern agriculture on the environment, genetically-engineered crops threaten further ecological degradation, thereby exacerbating food security for the poor.

As long as access to food depends upon money, and poorer people are excluded from food markets or land, significant numbers of people will be malnourished, hungry and starving - whatever happens to the global food supply and whatever happens to the number of people in the world.

Feeding Animals, Not People

"Much of the genetically engineered soya and maize being grown in the United States will be eaten by animals, not people"

The biotech industry's claim that its research is motivated by a need to feed the hungry is not substantiated. Few of the foods it has produced so far are likely to benefit poorer people in the South.[4]

The two main genetically-engineered crops being grown commercially in the United States, for example, are soybeans and maize (corn). Some 90-95 per cent of soybean harvests and 60 per cent of traded maize are not consumed by humans but by livestock.[5]

Animal feed is likely to continue to be an important focus of genetic research. In 1998, for example, Monsanto announced a joint venture with the world's largest grain merchant, Cargill, to create and market new grain processing and animal feed products "enhanced though biotechnology".[6]

The development of genetically-engineered feed crops will do little to relieve hunger in countries such as India where many people do not eat meat. Worldwide, it is estimated that two out of every three human beings have a primarily vegetarian diet.[7]

"Meat is consumed by people who are already well-fed and who have money to buy it"

Even in countries where meat is more widely eaten, feed crops do little to alleviate hunger. In the first place, converting animal feed to meat is a singularly inefficient means of supplying people with protein.[8] World hunger could be lessened if people ate the plant protein directly rather than eating meat. An acre of cereal is estimated to produce five times more protein than an acre devoted to meat production; an acre of legumes (such as beans, peas, lentils) ten times more; and of leafy vegetables, fifteen times more.[9]

Second, meat tends to be consumed by people who are already well-fed and who have the money to buy it. A 1987 survey of consumption patterns in over 50 countries found that higher income groups consistently derived more of their fat, proteins and calories from animal sources than lower income groups.[10]

Moreover, livestock production in many Southern countries has often been at the direct expense of poorer people's diets. Egypt is a case in point. Encouraged by the US government's Agency for International Development (USAID) and other development agencies, the Egyptian government invested heavily in livestock. From 1970 to 1980, crop production rose by 17 per cent in real terms, but livestock production grew almost twice as much, by 32 per cent. In the following seven years, crop production increased by 10 per cent, while livestock production leapt by almost 50 per cent.

"Egypt now grows more food for animals than for people"

Feeding the country's expanding population of animals required an enormous and costly diversion of staple food supplies from humans to animals. Human consumption of domestically-grown maize and other coarse grains dropped from 53 per cent of production in 1966 to just 6 per cent in 1988. Egypt now grows more food for animals than for humans - almost 40 per cent of the total agricultural land is under animal fodder crops. Human supplies of grain have been made up through US imports which contributed to Egypt's external debt; in 1988, the country's debt was five times the value of its exports. The consistent beneficiaries of Egypt's switch to livestock production have been large US grain merchants such as Cargill which have exported US grains at hugely subsidised prices to Egypt [11] (**see Box: Dumping Food on the South).**

Engineering for Retail Convenience

Much genetic engineering research in food has been directed at meeting the commercial needs of food processors rather than the nutritional needs of poorer consumers.

Monsanto's high-starch potato, for example, has been developed to make commercially-grown potatoes more suitable for the deep-fry vats of Northern fast food outlets, not to be a better or cheaper food.

Flavr Savr tomatoes were engineered by Calgene (now part of Monsanto) for delayed ripening so that they would have a longer supermarket shelf life. In the US, they had to be withdrawn from sale because the texture and taste did not meet with public approval and because they bruised during transport. (The tomatoes are now processed into tomato purees.

"Much of the research has been directed at meeting the commercial

wishes of food processors rather than the nutritional needs of poorer consumers"

The European Union has funded research into engineering the leaves of cauliflowers to stay green for longer so that the vegetables appear fresher - even though people don't usually eat the leaves.[12]

Much of the soya that is not used for animal feed, meanwhile, goes into processed foods; an estimated 60 per cent of processed foods, ranging from bread, ready-meals and sauces to biscuits, cakes and chocolate, now contain substances derived from genetically-engineered soya.

Such processed foods cannot provide many of the health benefits associated with eating fresh foods. Recent research in Britain, for example, found that:

"daily consumption of fresh fruit was associated with a 24 per cent reduction in mortality from ischemic heart disease, a 32 per cent reduction in mortality from cerebrovascular disease, and a 21 per cent reduction in all-cause mortality when compared with less frequent fruit consumption."[13]

The fact that the average consumption of fresh fruit is declining amongst low-income groups stems partly from the retailing systems associated with the long-distance transport of foods that genetic engineering will facilitate. More and more food in Northern countries is now transported further and further away from its point of production by road - trucks effectively becoming mobile warehouses. Supermarket chains have built new out-of-town stores as close as possible to major roads. Poorer people who do not have cars are left to buy food at corner shops, convenience stores or independent small supermarkets where prices are on average 23 per cent higher than those in large supermarket chains and discount stores - and where food may be even less fresh than in out-of-town stores. Significantly, a 1996 study of malnutrition among poorer families in Britain points out that "by far the most energetic action" to address the problem of expensive low-quality food has come "from within deprived communities, which have set up projects to improve access to healthier food, for instance, food-buying cooperatives, bartering projects and subsistence agriculture."[14]

A report by the US Biotechnology Industry Organization, meanwhile, suggests that effort in future will be devoted to genetic techniques for delaying ripening or rotting of fruits and vegetables and for improving their appearance, thereby allowing them to be transported over ever longer distances and kept on supermarket shelves for longer.[15]

These technologies may allow some fruits and vegetables grown by commercial producers in the South, such as mangoes, papayas and Charentais melons, to reach Northern niche consumers more easily. But the establishment and extension of trade between high-tech producers in the South and well-off Northern consumers is unlikely to contribute much to the nutritional health of hungry people in either South or North. Maintaining a system whereby food has to travel such long distances may be good news for oil companies, airlines and motor manufacturers, but it is nonetheless an energy- and resource-intensive system which is highly polluting.

The interests of all consumers would be better served not by promoting genetically-engineered food but by encouraging food to be grown and consumed as close as possible to the point of

production, giving consumers and growers, not transnationals, greater control over their markets.

"The interests of consumers and growers would be better served by giving them, rather than transnationals, greater control over their food and markets"

Substituting Tropical Cash Crops

"Genetically-engineered substitutes for tropical cash crops are likely to destroy the livelihoods of many rural poor people and aggravate poverty and hunger"

Several applications of biotechnology are aimed at growing tropical cash crops in the North, or at producing in laboratories the substances currently derived from such crops. If these applications work, they could have a severe impact on the national incomes of many Southern countries and on the incomes and employment opportunities for many individuals and communities in those countries.[16]

Approximately 70,000 vanilla farmers in Madagascar, for instance, face ruin because the market for vanilla is being undermined by the growing of vanilla under tissue culture in biotech labs.[17] Vanilla accounts for 10 per cent of Madagascar's export earnings.

Likewise, an estimated 10 million sugar farmers throughout the South face the loss of their livelihoods as a result of genetically-engineered sugars and sweeteners being grown and processed in the North. Fructose produced by genetic engineering has already captured over 10 per cent of the world market.[18]

Canola (or spring rape, currently being field-tested in Britain), meanwhile, has been genetically-engineered to produce oils which would replace the use of coconut and palm oils. If the technology works, export earnings of countries such as the Philippines, the world's largest exporter of coconut oil, will be reduced. Coconut oil provides seven per cent of the Philippine's total export income and direct or indirect employment for 21 million people, about 30 per cent of the country's population.[19] An estimated 10 million people in Kerala, India, who rely directly and indirectly on coconuts are also at risk from the new technology.[20]

The chocolate market is also vulnerable to the development of genetically-engineered cocoa butter substitutes, potentially displacing millions of small-scale producers in West Africa.[21]

Although some of these cash crop producers will be able to switch to growing other crops, many will not - either because they lack the money to buy the equipment needed to diversify or because they are unable to service the loans they have incurred in growing the cash crops and must therefore forfeit their land. Still others - landless labourers on commercial farms, for example - are likely to find themselves without work. With their income from export earnings slashed, few

Southern countries will be in a position to compensate such workers and farmers.[22] They will be left to fend for themselves: many are likely to become malnourished for lack of cash to buy food.

It is not surprising that some commentators warn that using genetic engineering to create substitutes for tropical cash crops will "destroy the livelihoods of the rural poor and aggravate conditions of poverty and hunger".[23]

Terminating Livelihoods

"Genetic engineering companies are attempting to stop farmers from planting seed they have harvested"

A further threat posed by genetically-engineered crops to the livelihoods of small farmers, not only in the South but also in the North, comes from attempts by the industry to deny farmers' their ancient right to save and exchange seeds from previous harvests and to force them to buy their seeds every year at a price determined by seed companies.

Over the last 30 years, commercially-bred hybrid seeds (which farmers buy from seed merchants) have become increasingly common. In the North, almost all farmers use them, even organic farmers. In the South, although non-hybrid crops are commonly used by smallholders for growing vegetables and staple foods (such as cassava, sorghum and millet), hybrid seeds have become the norm for many grain crops (although small grain cereals, such as rice, wheat, barley, oats and rye, have defied commercial hybridisation).

Hybrids do not breed true in the second generation; they are either sterile or their seed is not uniformly like the parent seed and thus "there is a reduction in overall performance when hybrid seed is saved and replanted".[24] In Northern countries, many farmers no longer use farm-saved seeds - partly because of lower yields but also because of the insistence of food processors and retailers on crop uniformity - although a substantial number continue to do so to grow wheat and barley.

"The 'Terminator Technology' threatens to extinguish farmer expertise in selecting seed and developing locally-adapted varieties -- a clear threat to food security and agricultural genetic diversity"

In the South, saving hybrid seeds is more widespread. As researchers Ricarda Steinbrecher and Pat Mooney point out:

"Resource-poor farmers in countries such as Brazil will often take second-generation seeds as a source of breeding material to be blended with their traditional varieties. In this way, skilled local breeders (mostly women) isolate useful genetic characteristics and adapt them to their immediate market."[25]

Seed companies have been able to develop hybrids only by appropriating plants developed and maintained by generations of farmers. Many countries in the North now have legislation requiring farmers to pay royalties to the seed companies on any "farm saved" seed that they plant out.[26]

Companies such as Monsanto are trying to tighten their control over "their" seeds still further by prohibiting farmers from saving any seed at all, even for their own use. When farmers buy seed engineered to be tolerant to the company's proprietary herbicide, Roundup, for example, they have to sign a contract stating that they will not save any transgenic seed for the next year's planting.[27] In the United States, Monsanto has reportedly employed private detectives to identify farmers who had violated the contract so that it can sue them. Before the genetically-engineered soybean seeds were introduced, an estimated 20-30 per cent of all soybean fields in the US Midwest are typically planted with saved seed.[28]

Monsanto's ultimate threat comes from what has been called "terminator technology": a method of incorporating two or three novel genes into a plant which cause its seed, if planted out, to die in the early stages of germination.[29] The terminator technology, if it works, would make it almost impossible for farmers to grow food from seeds they have saved. They would have no option but to go back year after year to the company to buy seeds. The technology's primary targets are, according to the original patent holders, "Second and Third World countries"[30] and self-pollinated crops such as cotton, soybeans and wheat.

"Genetically engineering plants so that their seeds do not grow is a brutal illustration of the supremacy of the profit motive in biotechnology"

Dr. Harry B. Collins, technology transfer vice president of Delta and Pine Land, the US company (now bought up by Monsanto) that developed the terminator technology together with the US Department of Agriculture, argues that the technology's:

"ability to prevent multiple use from one purchase of improved varieties of self-pollinated crops will benefit the world agricultural community by insuring that farmers in all areas of the world have an opportunity to share in the advantage of enhanced planting seed".

Is it really an "opportunity", however, if farmers have little option but to grow such seed?

Collins expands further on his idea that what is good for business must be good for farmers:

"The centuries-old practice of farmer saved seed is really a gross disadvantage to Third World farmers who inadvertently become locked into obsolete varieties because of their taking the 'easy road' and not planting newer, more productive varieties."[31]

The 1.4 billion resource-poor farm families whose food comes from seeds they have saved and developed from previous harvests may take a less sanguine view of this anti-life technology which could drive them out of plant breeding. Collins seems not to be aware that it is actually creative farmers who have generated and conserved productive varieties in their fields for decades. Such

farmers grow 15-20 per cent of the world's food.

Moreover, if Monsanto succeeds in inserting the terminator technology into its seed varieties while maintaining its relationship with Cargill, farmers could have little choice but to buy its non-reproducing seed, given that Cargill has near-monopolies over several agricultural commodities in many parts of the developing world.

As David King of *Gen*Ethics *News* says, "Every now and again, something comes along that shines a light on the real interests driving genetic engineering". The terminator's "system for preventing farmers replanting seed is as pure and brutal an illustration as we are likely to get of the supremacy of the profit motive in biotechnology."[32]

The technology's inventors readily admit this motive. Delta Pine and Land's Collins candidly describes the "protection system" for use in self-pollinated crops as "a breakthrough that will give companies a way to receive a fair return on their investment". USDA molecular biologist Melvin J. Oliver states that "our mission is to protect US agriculture and to make us competitive in the face of foreign competition".

Increasing the Costs of Farming

"The need to buy seeds every year and the chemicals that go with them will force many more farmers into bankruptcy"

For many farmers, the need to buy seeds every year (instead of using saved ones) will lead to a steep rise in their input costs and, in many cases, bankruptcy. Without land on which to grow food, many small producers will face destitution and hunger - hardly a policy for "feeding the world".

Monsanto says that it has yet to decide on the prices for many of its genetically-engineered seeds.[33] But there are already indications that its Roundup Ready seeds could cost more than conventional varieties. In the US, for example, most seed costs around $15 for a 50 pound bag, enough to plant one acre. In 1997, Roundup Ready soybean seed retailed for more than twice that;[34] in addition, farmers had to pay a "technology fee" of $8.00 an acre to Monsanto. Since then, the company has dropped some of its prices because of a depression in US agriculture.

For farmers who have large amounts of well-endowed land, rises in seed costs may not be problematic. Such farmers may well be able to use their buying power to obtain substantial discounts. Roundup Ready seeds may also bring larger farmers substantial "herbicide-driven" economies of scale, either by reducing the number of times a crop requires spraying to get rid of weeds or by reducing labour costs. For smaller farmers, however, the increased costs of seeds could prove ruinous.

Growers in the South, whose economic survival relies on being able to save seed from one year to the next, are also likely to be ruined by the added input costs. Not only will they have to pay for their seeds every year: they will also have to buy chemical herbicides and fertilizers. Herbicide use in Southern countries, particularly on smaller farms, is low because it is cheaper to employ people to get rid of weeds. Many small farmers, who are already hard pressed by competition from heavily-subsidised food imports from the EU and the US [35] (**see Box: Dumping Food on the**

South) and by the removal of subsidies on water and energy due to structural adjustment programmes, will slide into debt.

Just as with the Green Revolution, the result is likely to be a new wave of farm bankruptcies, leading to landlessness for poorer farmers and an increased concentration of land as wealthier farmers and speculators buy up bankrupted farms. (**see Box: Increasing Landlessness**) In South Korea, the number of rural households in debt rose from 76 per cent in 1971 to 90 per cent in 1983 and to 98 per cent in 1985, following implementation of the Green Revolution.[36] As a result, farmers left the land in droves: 34,000 migrated to the cities in 1986, 41,000 in 1987 and 50,000 in 1988. In the Indian Punjab, the high input costs of Green Revolution technologies led to the number of smallholdings declining by nearly a quarter between 1970 and 1980. Many were left destitute - a prospect that the Gene Revolution now threatens for many of those who survived the turmoil of the Green Revolution. (**see Box: Haven't We Been Here Before? The Green Revolution**)

Promoting Inefficient Farming

"The overall result of displacing 'inefficient' small growers is likely to be increased famine and malnutrition -- not a redution in hunger as the proponents of genetic engineering claim"

Proponents of genetic engineering in agriculture may argue that such farm bankruptcies are a regrettable but necessary price of greater efficiency in agriculture.[37]

In terms of output per unit of labour, small farms do tend to be less "efficient" than large modernised ones. But in terms of gross output per unit of land, smaller farms often outdo larger ones. Reports from the UN Food and Agriculture Organization repeatedly show that small farms in the Third World are more productive than large holdings. In Thailand, holdings under one hectare have been found to be almost twice as productive as holdings over 40 hectares; in Sudan, holdings of less than half a hectare are four times as productive as those of 15 hectares; and, in Bangladesh, holdings of just 0.3-0.4 hectares are six times more productive than those of three hectares.[38]

Arguments for replacing "inefficient" small producers with "efficient" large producers also fail to take account of the key role that small farms (particularly household gardens) play in efficiently supplying informal household networks with food, particularly in rural areas of the South - food which never reaches the market and thus tends to be omitted from official figures of production. To displace such networks would almost certainly result in a dramatic fall in the amount of unmarketed food available to poorer people.[39] It would also mean that many households would have to buy their food. How much food and what kind of food people get to eat would depend on their ability to earn money or on the state's willingness to support them (**see Box: Politics of Hunger**).

Increasing Destitution

If vulnerable smallholder producers are displaced as a result of growing genetically-engineered crops, there is the threat of more poverty and food insecurity. Many of those displaced would probably find themselves in a saturated labour market. If they could get jobs, they would no doubt be low-paid, insecure ones in the cities or on larger farms where workers are generally paid piece rates.[40] Real wages for labourers have been rapidly declining in many Third World countries. As writer and researcher Jon Bennet remarks of the estimated 1.75 million seasonal labourers who compete for work in the cotton growing areas of Sudan:

"Stripped of their traditional means of support, farmworkers [have] become simply components of production. . . . increasingly vulnerable to the shifting fortunes of an economy outside their control. As a seemingly limitless resource with minimal bargaining power, they [can] now be hired or fired at will."[41]

Those working as labourers in export crop plantations have been particularly vulnerable to exploitative wages and working conditions. Because exporters rely on markets abroad rather than at home for the sale of their crops, low wages are not "necessarily so bad for business" since "profits do not necessarily significantly depend on the ability to sell domestic products to wage earners or peasants".[42]

The overall result of displacing "inefficient" small farmers is thus likely to be increased famine and malnutrition - not a reduction in hunger as the proponents of genetic engineering promise.

PART II: UNSUSTAINABLE AGRICULTURE

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"Genetic engineering in agriculture is likely to have adverse environmental impacts which would undermine the ecological basis of food production"

Genetic engineering in agriculture is likely to have adverse environmental impacts which are in turn likely to undermine the ecological basis of food production. Genetically-engineered crops will stimulate the evolution of "superweeds" and "superbugs" which will necessitate higher doses of chemicals and make food supplies more vulnerable to pest damage. The outcrossing of engineered traits to other plants also poses a major threat to food production. In addition, the adoption of genetically-engineered crops is likely to reduce genetic diversity, resulting in fewer and fewer types of food crops; the narrowing of the genetic base of food adds to the likelihood of pest and disease epidemics. Many of these problems stem from the fact that genetically-engineered crops will be grown in industrial monocultures. Other forms of agriculture offer far safer, proven and ecologically-benign means of protecting crops against pest damage. (**See Box: Monocultures, Pests & Genetically-engineered Crops**)

Increasing Chemical Use and Soil Degradation

Proponents of genetically-engineered food argue that genetically-engineered crops will enable

farmers to reduce the use of chemicals on the land, chemicals which the industry used to promote as "safe" despite evidence to the contrary but now acknowledges to be detrimental to the environment in general and to the health of soils in particular.[43] In reality, however, genetic engineering offers little prospect for reducing chemical use.

About two-thirds of the genetically-engineered crops now being grown on a commercial scale have been engineered to be tolerant of a specific herbicide. Monsanto, for instance, has created soybeans, cotton, oilseed rape, corn and sugarbeet so that these plants are not killed off when the company's top-selling weedkiller, Roundup, (whose active ingredient, glyphosate, tends to kill off most plants) is applied to a field. Monsanto argues that growing Roundup Ready crops will reduce herbicide use by up to 39 per cent.[44]

Some individual farmers may well be able to reduce (but not eliminate) their use of herbicide by growing Roundup Ready seeds. But if more farmers use these seeds, particularly those who do not currently use Roundup or other weedkillers, more herbicide is likely to be applied overall.

Moreover, just as bacteria which cause illnesses in humans have gradually developed resistance to antibiotics, so too weeds in or near fields of genetically-engineered crops will become resistant to the herbicide. Such "superweeds" will require higher and higher doses of herbicide, leaving larger and larger amounts of chemical residue behind on crops.[45]

In some cases, the herbicide sprayed on fields growing the genetically-engineered crops may well be more toxic than the chemicals applied to fields of non-engineered seeds. Oilseed rape, for instance, has been engineered by AgrEvo and Plant Genetic Systems[46] to tolerate the herbicide, glufosinate (marketed by one of the parent companies, Hoechst, under the brand names Liberty, Basta, Harvest and Challenge). Glufosinate is a broad spectrum herbicide and thus affects more plants than other more specific weedkillers. As the group GeneWatch points out, "Any reduction in herbicide use would be directly attributable to glufosinate's potency. Hence, whilst it may be true that fewer litres will be required, the toxic effect will be the same or even greater." GeneWatch also point out that:

"Any reduced usage claim seems even less convincing when AgrEvo have increased production facilities for glufosinate in the US and Germany and expect sales to increase by $560 million in the next five to seven years. Indeed, the introduction of glufosinate resistant crops to increase sales of its herbicide products is considered to be AgrEvo's underlying aim in entering the GE market in the first place."[47]

The effects of chemical herbicides are well-documented. They reduce soil fertility, pollute water, deplete earthworms and beneficial microbes, and have varying short- and long-term affects on human health.

While Monsanto has claimed that its glyphosate weedkiller, Roundup, is "environmentally friendly", "biodegradable" and "practically non-toxic" to mammals, birds and fish, there is mounting evidence that glyphosate-based herbicides can be lethal to beneficial insects such as ladybirds and lacewing flies which are predators of common agricultural pests such aphids.

Glufosinate, meanwhile, is toxic to plants, fish and other aquatic life; laboratory animal studies have linked the chemical with birth defects.

Evolving Superbugs

"Just as herbicide-resistant crops are likely to trigger the evolution of 'superweeds', so pest-resistant crops could accelerate the evolution of 'superbugs'"

The next most common application of genetic engineering in agriculture is the development of crops which produce their own insecticide; pest resistant crops are now being commercially grown in the United States. In theory, such crops might seem to eliminate the need for external applications of chemical insecticides (to the benefit of the health of farmworkers and consumers as well as the soil) and to reduce crop loss caused by insects. Just as herbicide-resistant crops are likely to trigger the evolution of "superweeds", however, so too these crops could well accelerate the evolution of "superbugs".

The most common way of engineering pest resistance has been to splice into a plant a gene derived from a soil bacterium, *Bacillus thuringiensis (Bt)*.[48] This organism produces a protoxin which, when eaten by some insects and their larvae, destroys their digestive tracts and kills them.

The substances produced by the genetically-engineered *Bt* plants, however, do not need to be activated by insect stomach fluids but are immediately toxic. They can survive in soil and keep their toxicity for up to nine months, whereas the naturally-occurring toxin degrades at least two to three times faster.[49] Genetically-engineered *Bt* toxins thus harm and kill a far wider range and number of insects, including beneficial ones, than the naturally-occurring toxin. They also affects soil organisms.

Continuous production of the *Bt* toxin by genetically-engineered plants creates a strong selection pressure on insects to develop resistance. The evolution of "superbugs" which are resistant to the toxin or which switch to eating other plants is highly likely. Once this occurs, farmers will have to return to using chemical insecticides - until the pests evolve resistance to these too.[50] Some scientists believe that the window during which genetically-engineered *Bt* products will be effective is less than a decade, perhaps only three to four years.[51] From a corporate perspective, this only adds to pressures to rush these products on to the market before competitors do so.

Some scientists, meanwhile, are seeking to engineer plants to be resistant to fungi, bacteria and viruses. Field trials involving tomatoes, potatoes, squash, cucumber and cantaloupe have already taken place. Evidence is accumulating that engineering viral resistance in plants could lead to the development of new viruses, which could give rise to potentially more serious diseases.[52] It has been reported, for instance, that naturally-occurring viruses can recombine with the virus fragments spliced into plants.[53] Any new crop diseases, especially those occurring on an epidemic scale, would not increase food supplies or food security.

Crossing Out of Genetically-Engineered Organisms

Cross-pollination between genetically-engineered crops and non-engineered varieties or wild relatives could undermine food security still further. The transfer of herbicide resistance to other

plants, for instance, could lead to the emergence of new species of weeds which would be difficult to eradicate and which could disrupt ecosystems by displacing existing flora.[54] Such hybridisations have already been demonstrated in field experiments with wild radish, wild turnip, hoary mustard and mustard greens.[55] In the case of genetically-engineered potatoes, hybridisation readily occurred with non-engineered varieties over distances up to one kilometre.[56]

The resulting hybrids will not necessarily die out quickly. Recent studies in Denmark reveal that the transgene for herbicide resistance in genetically-engineered oilseed rape not only spread easily to weeds but produced fertile, weed-like plants after just two generations of hybridization and backcrossing.[57]

Indeed, the sheer numbers of genetically-engineered organisms now being released into the environment through field trials and commercial growing make it almost inevitable that at least some of the novel genes - particularly those that confer survival advantages to plants such as herbicide tolerance and pest resistance -will cross out, persist, spread out of control and affect ecosystems in unpredictable ways.

"Some novel genes are bound to spread into other plants through cross-pollination and affect ecosystems in unpredictable ways - destroying genetic diversity especially in countries of the South which are the centres of origin of crops"

The risks of such cross-pollination are likely to be greater in the countries of the South than the North, since North America and Europe have few relatives of crops such as rice or soybeans to which the spliced-in genes could spread through cross-pollination. But many of the Southern countries where genetically-engineered crops may be grown - including China, India, Thailand, South Africa and Brazil - are the genetic centres of origin for these crops, easing the spread of transgenes (the gene constructs inserted into crop plants). For this reason, the US Academy of Sciences specifically warns that "greater care may be needed in the introduction of genetically modified crops" in Asia Minor, South-East Asia, the Indian subcontinent and South America than in North America.[58]

Acknowledging these concerns, the industry cites its "terminator technology" (*see* pp.9-10), arguing that it would prevent the offspring of genetically-engineered crops from germinating. When the genetically-engineered plants cross-pollinated with wild relatives, the resulting plants would be unable to survive, argue the technology's proponents. But similarly the terminator technology could spread to neighbouring crops as well, with potentially calamitous effects on food production. As the farmers' rights advocacy group, RAFI, point out:

"Even sporadic germination failures will be sufficient to scare farmers away from saving seed that might not grow. The patent holders don't have to have a perfect technique in order to threaten farmers who can't afford risk".

It is not just to plants that transgenes could be transferred. A recent study has shown that they can be transferred to soil bacteria as well, which could then be picked up by insects, birds and animals, and carried into water supplies.[59]

Destroying Genetic Diversity

"Genetic engineering will narrow, not increase, the genetic base of food crops, threatening the very basis of human nutrition"

Genetic engineering in agriculture will hasten the further erosion of food genetic diversity, no matter how many "new" types of crop are created. Splicing the odd new gene or two into a restricted set of cultivars does nothing to compensate for the massive loss in the base of genetic diversity. This had been painstakingly built up in wild varieties through long-term evolution in millions of unique locales and developed in myriad domesticated varieties through millennia of small farmers' innovative breeding efforts. Narrowing the genetic base of agriculture to only a few types of crop erodes long-term security of agricultural yields and therefore the very basis of human nutrition.

Genetic engineering companies, as a matter of business principle, are continuing the strategy already pursued for many decades by corporate plant breeders and seed companies (in tandem with food processors and retailers) of creating uniform national (and now international) markets for just a few standardized seeds and chemicals. Seed varieties suitable only for a specific locality are neither promoted nor developed. A few decades ago, Indian farmers were growing some 50,000 different varieties of rice; just over ten years ago, this number had dropped to 17,000; and today, the majority grow just a few dozen. In Indonesia, 1,500 local varieties have become extinct in the last 15 years. If different varieties, each of which have different traits , are not grown out constantly, they are very quickly lost.[60]

The demands of food processors for a particular type of uniform crop accentuates the loss of genetic diversity. Of the 150 varieties of potato legally available in Britain, for instance, just 10 account for more than 70 per cent of the acreage planted to potatoes.[61] Thus as writers Marc Lappé and Brit Bailey conclude:

"The increasing trend towards uniform farming practices . . . is almost certainly going to be exacerbated by the availability of transgenic seed. The resulting crop patterns may well increase the fragility of the crop and permit the introduction of widespread disease."[62]

Some farmers in the United States growing genetically-engineered soybeans are already discovering that monocultures of a single genetically-engineered variety may be more susceptible to disease. Sudden Death Syndrome, a disease caused by a soilborne fungus, *Fusaruim solani*, affected soybeans in central and northern Missouri in the late summer of 1998, potentially reducing yields. Some observers estimated that 80 to 90 per cent of some affected areas were planted with Roundup Ready seeds. Commented one farmer who could lose up to half his yield, "I think there was a rush to get some variations [of genetically-altered soybeans] on the market that

didn't really have good disease resistance".[63]

Genetic engineering, in short, will do little to reduce overall chemical use, nor to prevent crop losses due to pests and diseases - and could make these problems far worse.

PART III: CHOICE? WHAT CHOICE?

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"Genetic engineering companies and their allies are moving rapidly to deny farmers the possibility of planting non-engineered crops -- and control of the food chain from seeds to food on consumers' plates"

Given these ecological, economic and social risks, many farmers - if they had access to full information - might prefer not to grow genetically-engineered crops. But genetic engineering companies and their allies are moving rapidly to deny farmers the opportunity of planting non-engineered crops. If history is any guide to the future, the companies involved will probably use their political and economic muscle to achieve this goal. Several tactics are likely in both the North and the South. Taken together, they contradict the assertions that "traditional seeds will continue to be available just as they are now" or that concerns about farmers losing access to seeds, not being able to save or exchange seeds and becoming dependent on plant breeders are "largely unfounded".[64]

Monopolies From Seed to Supermarket

Mergers, takeovers, joint ventures and licensing agreements between plant breeding companies, seed distributors, grain traders, chemical companies and genetic engineering interests have resulted in some genetic engineering companies gaining near-monopoly control over the growing and marketing of some agricultural commodities. Monsanto's chair and chief executive, Bob Shapiro, is candid about his company's aims:

"In the past, we've supplied agricultural inputs to help farmers grow crops . . . Increasingly, we're looking instead at creating value throughout the chain, running from seed and inputs all the way through to consumers."[65]

Just ten multinationals (including Monsanto) have now cornered nearly 40 per cent of the world seed market.[66] Monsanto itself estimates that half the US grain industry is now using its genetically-engineered seed; it expects that by the year 2000, all soybeans planted in the United States will be of its Roundup Ready variety.[67]

In the immediate future, it is likely that farmers in the North will be most directly affected by such monopoly control. Within a few years, the only soybeans Monsanto is likely to offer in Japan will be genetically-engineered ones.[68]

In Ireland, where Monsanto and Swiss company Novartis are trying to get Roundup Ready sugarbeet approved for commercial growing, Monsanto has warned that Novartis, the country's major supplier of sugarbeet seed, may find it "uneconomic" to "continue to supply traditional seed to the Irish market".[69]

The advent of the terminator technology, however, will hasten the eagerness of the major genetic engineering firms to exploit the potential market of some 1.4 billion households in developing countries who currently rely on largely "unimproved" agricultural systems, that is, who save their seeds from year to year rather than buying them in. The companies feared that, without the technology, they would be unable to enforce royalty payments on any farm-saved seed in countries without effective legislation to "protect" plant breeders, or to enforce contracts forbidding such seed saving. Now, they have a technology that will make it "safe" for seed companies to sell their high-tech varieties in Africa, Asia and Latin America.

"It is truly easy to make a great deal of money dealing with very primary needs: food, shelter, clothing." Monsanto

For the companies, the commercial potential is huge. As Monsanto's Bob Shapiro recently told readers of the house magazine of the International Finance Corporation (IFC), the private sector wing of the World Bank which focuses on private investment in developing countries, "It is truly easy to make a great deal of money dealing with very primary needs: food, shelter, clothing."[70] Research is already being conducted on cassava (*Manihot esculenta*), an important source of dietary carbohydrate in Africa, while Monsanto has started collaborating with scientists in Kenya to produce transgenic sweet potatoes resistant to feathery mottle virus.

A Condition of Credit

"The provision of small loans to poor people to grow genetically-engineered crops is one way of getting them hooked"

Government agencies, banks and other credit agencies are likely to be persuaded to make the adoption of genetically-engineered crops a condition of obtaining credit. Credit will be given for these crops and their inputs, but not for others. This practice was widely encouraged during the Green Revolution.

Monsanto is already seeking to foster strategic alliances with microcredit organisations which provide small loans to poor farmers, many of whom are women. The company sees microcredit as "a way to develop new markets by helping the people in those markets participate in economic development."[71] Monsanto reports that it is "striving to have at least one microcredit project

operating in each of its world areas by the end of 1998", is "working with third-party organizations in Indonesia, India and Mexico" and "is also in the early stages of investigating partnerships in such areas as Eastern Europe, China, South Africa, sub-Saharan Africa and parts of Latin America."[72] In 1998, Monsanto's attempt to set up a joint venture with Bangladesh's famous Grameen Bank, which provides credit to the poor, was derailed by public protests that the deal would only help hook the country's poor farmers on expensive Monsanto products.[73]

Restricting Traditional Varieties

"Seed companies could take non-engineered crops off national seed listings, or simply stop supplying them"

Seed companies may well take conventional varieties off the market - a grave threat to organic farmers - or use existing seed and patent legislation to restrict farmers growing such varieties.

The recent experience of Scottish seed potato growers may be a portent of things to come. In the early 1990s, the corporate holders of plant breeding rights over certain varieties of (non genetically-engineered) potato began to enforce their rights, enshrined in British law for some 30 years but not yet exercised, to stipulate who could grow the seed potatoes and to whom they could be sold. A number of growers were forced out of business.[74] It is not inconceivable that similar legislation could be used to prevent farmers growing conventional varieties that were "in competition" with genetically-engineered varieties marketed by the same seed firm.

Countries in the South are under pressure to adopt legislation to protect plant breeders' rights, which would be to the advantage of multinational seed oligopolies.[75]

Channelling Agricultural Research

"By sucking up vast research funds, genetic engineering is denying money for research into other forms of agriculture"

Companies are channelling agricultural research towards biotechnology through the judicious use of grants to university and agricultural colleges. Monsanto, for example, has donated at least $23.5 million to Washington University for biotech research; the German company Bayer is contributing to the Max Planck Institute in Cologne for the same purpose; while another German-based company, Hoechst, built an entire $70 million biotech research laboratory for the Massachusetts General Hospital where research on crop genetics is also carried out.[76] Concern is spreading that research on staple foods will follow the genetically-engineered direction as well.[77]

By sucking up vast research funds, genetic engineering is denying money for research into other forms of agriculture - such as intercropping and crop rotation (*see* p.26) - that are far more effective in alleviating the problem of pests.

Inevitably, these donations not only give companies some control over what is researched; they also help direct the curricula of educational colleges, particularly agricultural colleges, creating an institutional framework that is broadly sympathetic to the industry's aims and views.[78] As the research filters down into the agricultural extension services, it also helps take the companies' message out into the fields, extension officers being a major source of advice for farmers both North and increasingly South.[79]

Peer Pressure

Finally, companies will hope to create "peer pressure" on farmers to adopt the new crops through public relations campaigns, some of them paid for with public money. In Europe, for example, Hoechst and other major genetic engineering companies have contributed £1 million each to the European Commission's FACTT project which aims to familiarise "farmers, extension organisations, the processing industry, regulatory organisations, consumer groups and public interest groups" with crops incorporating transgenic technologies such that they come to accept them.[80] In effect, as GeneWatch comments, the project - to which the EU has contributed £1 million of public funds - is little more that "a sales promotion for the GE oilseed rape developed by Hoescht subsidiaries, AgroEvo and Plant Genetic Systems".[81]

PART IV: ALTERNATIVE ROUTES

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Opposition to the imposition of genetically-engineered foods is growing worldwide as increasing numbers of people learn about the risks of growing and consuming them, and about their potential to increase hunger and poverty. Austria and Luxembourg have banned the import of *Bt* maize. France recently brought in a two-year ban on commercial growing of the herbicide-resistant oilseed rape produced by AgroEvo and Plant Genetic Systems. In Britain, the government's wildlife adviser, English Nature, has called for a five-year ban on the commercial growing of *Bt* and herbicide-resistant crops. Also in Britain, major retailers have banned products made with genetic engineering in their foods, while others are actively seeking sources of soya and maize not produce via genetic engineering. Many local governments, meanwhile, have banned genetically engineered food from meals provided in schools.

Ensuring food security worldwide in fact requires an approach to agriculture that is, in almost every respect, the *reverse* of that being promoted by biotech companies and their allies in government and regulatory authorities, as an NGO statement to the United Nations' 1996 World Food Summit made clear. Fulfilling Monsanto's inspiring slogan "Food • Health • Hope" in fact requires acting against genetic engineering in every particular:

No Patents on Life

People's movements have demanded that legislation permitting patents to be taken out on genes and genetically-engineered organisms, including plants and animals, should be revoked, and that farmers' rights to save seeds freely should be enshrined in international law. Such movements are also demanding that World Trade Organisation (WTO) member countries should not be required to implement some form of national patent "protection" for plant varieties.[82]

Local Control

Instead of policies that concentrate control over agriculture in the hands of large landowners, corporations and distant bureaucrats, food security demands policies that increase the ability of smallholders and family farmers to exercise local and regional control over food production, distribution and marketing. Such policies would include redistributive agrarian reforms, strengthened tenancy legislation, a redirection of public investment towards staple food crops, and the enforcement of competition policies to break up corporate monopolies.

Revision of International Trading Rules

Instead of requiring countries to liberalise their agricultural markets, food security demands respect for the rights of nations to "achieve the level of food self-sufficiency and nutritional quality [they] consider appropriate without suffering retaliation of any kind". The agricultural agreements of the WTO which require countries to open up their agricultural markets to imports should be renegotiated. As Kevin Watkins of Oxfam, UK, argues:

"The WTO should enforce a comprehensive anti-dumping provision, outlawing the use of direct and indirect subsidies to gain market share. More importantly, a new food security clause is needed in the WTO which would entitle all food deficit countries to protect their food systems up to the point of food self-sufficiency, if their governments so chose."[83]

Equity

No matter how much food is produced, how few babies are born or how dramatically human numbers fall, there will always be those who are judged "surplus to requirements" and who are excluded from the wherewithal to live - unless there are changes in the social and economic relationships that currently determine the production, distribution and consumption of food in the world. The human population could be halved, quartered, decimated even, yet hunger would still remain: so long as one person has the power to deny food to another, even two people may be judged "too many".[84]

Organic Farming

Instead of encouraging the further industrialisation of agriculture, food security worldwide demands policies that favour non-chemical production with the genuine goal (as opposed to the

biotech version) of reducing or eliminating the use of pesticides and other agrochemicals.

Farmers all over the world have developed, and continue to develop, highly-sophisticated multiple-cropping systems that combine up to 20 crops in the same plot, thus optimising resource use, conserving soil fertility and avoiding major pest, fungal and viral problems.

The combined crop yields from multiple-cropping systems are often higher than those from monocultures. Research in West Africa, where 80 per cent of all farm land is intercropped, has shown that "in many cases yields from intercropping surpass those from sole cropping systems".[85] In regions such as eastern Nigeria, "intensified intercropping on permanently cultivated, manured and composted 'infield' farms is one of the ways in which farmers have responded to land shortages over the last 50-75 years or so."[86]

As agricultural researcher Jules Pretty reports, many farmers across the globe are already turning their backs on chemical agriculture to embrace regenerative methods of farming that often bring higher yields whilst still sustaining the soils and other aspects of the agroecosystem on which long-term food production depends:

"A million wetland rice farmers in Bangladesh, China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand and Vietnam . . . [are now using] alternatives to pesticides whilst still increasing their yields by about 10 per cent. In southern Brazil, some 223,000 farmers, using green manures and cover crops of legumes and livestock integration, have doubled yields of maize and wheat to 4-5 tonnes/ha. More than 300,000 farmers in southern and western India farming in dryland conditions, and now using a range of water and soil management technologies, have tripled sorghum and millet yields to some 2-2.5 tonnes/hectare."[87]

Monsanto's advertisement claiming that food biotechnology will feed starving future generations declares that "the implications for the sustainable development of food production are massive". This is indeed true - but not in the ways Monsanto has in mind.

Notes and References

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3. On average, 350 kg of cereal per person.

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24. Dr. Harry B. Collins, Delta and Pine Land Company, text circulated at the Fifth Extraordinary Session of the FAO Commission on Genetic Resources for Food and Agriculture, 1998.

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26. Many Southern countries do not have such plant protection legislation. However, the TRIPs (trade-related intellectual property) agreement of the World Trade Organisation stipulates that member countries must have legislation in place within a few years. *See* "Ten reasons not to join UPOV", Global Trade and Biodiversity in Conflict series, Issue 2, The Gaia Foundation/Genetic Resources Action International, London/Barcelona, May 1998 (available from Gaia, 18 Well Walk, London NW3 1LD, UK).

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30. USDA spokesperson Willard Phelps said that the goal of the technology is "to increase the value of proprietary seed own by US seed companies and to open up new markets in Second and Third World countries". *See* RAFI, op. cit. 28.

31. Dr. Harry B. Collins, op. cit. 24.

32. *Gen*Ethics *News*, op. cit. 29. British company Zeneca recently applied for a patent for its version of the terminator technology, dubbed the "Verminator" because it involves genes derived from fat tissue of a rat. *See* RAFI, ". . . And Now the 'Verminator'! Fat Cat Corp With Fat Rat Gene Can Kill Crops", press release, 24 August 1998. http://www.rafi.org/

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40. Many of these jobs could be destroyed by the introduction of herbicide tolerant crops. At present, herbicides account for just 15% of total agricultural chemical consumption in the South, as against 48% in the North.

According to FAO, the difference lies in low labour costs which "can make manual weed control more economical than herbicide use." *See* FAO, *Agriculture Towards 2010*, Rome, 1993, p.142.

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43. Until Monsanto sold off and spun most of its chemical division into a separate company, Solutia, in 1997 (keeping the weedkiller, Roundup, for itself), it was one of the largest polluters in the United States. It used to be one of the main producers of the highly-toxic defoliant, Agent Orange, and highly-toxic PCBs. Most large genetic engineering companies have a history of marketing toxic chemicals.

44. Affidavit of Stephen Moll, Roundup Ready Crop Director, Monsanto Europe, The High Court Judicial Review between Clare Watson and the Irish Environmental Protection Agency and Monsanto plc, Dublin, 1997.

Zeneca has filed a suit against Monsanto in the US, contending that Monsanto is "engaging in exclusionary and anticompetitive practices through the coupling of sales of biotech seeds to its own herbicides". *See* "Zeneca Files Antitrust Suit Against Monsanto", *Chemical Week*, 5 August 1998.

45. In some cases, herbicide residues are likely to increase on the edible portion of the crop. Monsanto has applied to the regulatory authorities in several countries to increase the "safe" residue limit of glyphosate in crops from 6 milligrams per kilogramme dry weight to 20 milligrams. The US Environmental Protection Agency and the EU have acceded to this request. The chemical residue limits for crops intended to feed livestock are much higher than those for human consumption. *See* Lappé, M. and Bailey, B., op. cit. 5.

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55. GeneWatch, op. cit. 47. *See also* Eber, F., et al., "Spontaneous hybridisation between a male-sterile oilseed rape

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60. Since rice was domesticated in Asia some 8,000 years ago, farmers and local communities have developed well over 100,000 different varieties. Some grow under five metres of rainfall per year, others do well in the desert; some do well when average temperatures are well over 30°C, others flourish in fresh and cool climates; some grow at or below sea level, others grow at high altitudes. Companies are unlikely to breed varieties that are highly suitable for a limited area.

61. Clunies-Ross, T., *Farmers, Plant Breeders and Seed Regulations: An Issue of Control*, The Ecologist Public Outreach Unit, 1996. *See also* Clunies-Ross, T., *Seeds, Crops and Vulnerability: A re-examination of diversity in British agriculture*, The Ecologist Public Outreach Unit, 1995, (both available from The CornerHouse, PO Box 3137, Station Rd, Sturminster Newton, Dorset DT10 1YJ, UK, £5 and £10).

The Irish potato crop failed last century because genetically-uniform crops were grown over a large area. After the famine, potatoes resistant to blight, the disease that ruined the plants, were brought over from Latin America to start planting anew. Given the drastic erosion in genetic diversity since that time, a process which genetic engineering, corporate concentration and restrictive legislation will hasten, there could well be no alternatives left if such an epidemic occurred in the future.

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64. First quote, Dr. Harry B. Collins, op. cit. 24; second quote, Peter Sutherland, when Director-General of GATT, cited in Clunies-Ross, T., *Farmers, Plant Breeders and Seed Regulations*, op. cit. 61.

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69. Affidavit of Stephen Moll, op. cit. 44.

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71. Monsanto *1997 Report on Sustainable Development*, St. Louis, Missouri, p.27.

72. Monsanto *1997 Report on Sustainable Development*, St. Louis, Missouri.

73. Microcredit programmes have long been run by self-help groups to provide credit to the poor, especially women, in urban and rural areas. Given the sudden interest in microcredit from an array of multinational companies, transnational banks and international financial and development institutions, however, critics stress the importance of distinguishing between microlenders whose primary goal is empowerment of the poor and those whose primary goal is profit. Microcredit from the latter, often given at high interest rates, keeps the poor trapped in a downward spiral of debt. See, for example, Dawkins, N. and Wysham, D., *The World Bank's Consultative Group to Assist the Poorest: Opportunity or Liability for the World's Poorest Women?*, Institute for Policy Studies, 733 15th st, NW, Suite 1020, Washington DC 20005, USA.

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75. "Ten reasons not to join UPOV", op. cit. 26.

76. Hobbelink, H., *Biotechnology and the Future of World Agriculture*, Zed Books, London, 1991, p.39.

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78. Hobbelink, H., op. cit 76, p.39. One researcher commented of the Hoechst grant for the biotech laboratory, "essentially everyone in that lab is an indentured servant to Hoechst".

79. See Clunies-Ross, T. and Hildyard, N., *The Politics of Industrial Agriculture*, Earthscan, 1992, London.

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81. GeneWatch, op. cit. 37.

82. "Ten reasons not to join UPOV", op. cit 26.

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Box1

Dumping Food on the South

Northern governments have long subsidised their industrialised farming systems for many decades to ensure national food self-sufficiency (at least in per capita terms rather than in distributional ones). But the subsidies have also caused these systems to generate vast surpluses of food which has been dumped on world markets at artificially low prices. Smaller farmers in the countries of the South find it hard to compete with cheaper (because subsidised by the home country) imported grains and local production of staple foods in many places has declined.

Subsidised food dumping is clearly connected to the creation of food dependence in sub-Saharan Africa. Three decades ago, the region was self-sufficient in basic food staples. Since the 1970s, however, wheat imports have increased by over 200 per cent. Net imports have risen three-fold from three million to nine million tons. The decline in per capita production from 135 kilogrammes to 112 kilogrammes over the same period is related to the rise in imports.

Food dumping played a key role in this surge in import demand. In the latter half of the 1980s, the US and the EU were selling wheat at $60 per ton in West Africa, one quarter of the price paid to EU farmers for their crop.

Local producers of staple food crops could not compete with these imports. Local markets collapsed, household incomes fell, and investment in agriculture declined, widening the gap between local production and demand - a gap which imports could step in to fill.

In fact, food deficits in the South have been assiduously cultivated by policymakers in the North. During the 1960s, a central objective of the US food aid programme was to translate demand for food in the South into demand for US wheat. By the mid-1960s, this programme accounted for over one-third of US cereal exports, laying the foundation for multi-million dollar markets in countries such as the Philippines and Colombia.

Agricultural liberalisation - encouraging or requiring countries to drop their restrictions on food imports - is the latest tactic being pursued by Northern countries to create further markets for their production. The last revision of GATT - the General Agreement on Tariffs and Trade (the rules governing international trade) - requires signatories to the Agreement to open up their markets to imports and to remove their subsidies to farmers if they do not want to face trade retaliation. The Agreement left intact, however, many of the subsidises given to Northern farmers.

The US Department of Agriculture estimates that liberalisation will create substantial market opportunities for US agricultural exporters. In South-East Asia, for instance, US policy makers expect consumers in South-East Asia to start eating products made from US wheat such as bread and pizza instead of locally-produced rice, cassava and maize. Kevin Watkins of Oxfam UK concludes that "South-East Asia is being sized up - and cultivated - as a dependent market for US food exporters."

The Philippine government plans to cut by more than half the amount of land planted to maize and rice, reducing it from five million hectares to two million hectares. The leftover three million hectares will be diverted to cash crop production and livestock. An estimated half a million people are likely to lose their livelihoods if these plans go ahead.

The benefits of food dumping have consistently accrued to grain traders such as Cargill which has now entered into a joint venture with Monsanto. Cargill enjoys considerable influence over US and international agricultural policy. During the GATT agriculture negotiations, the company was a key adviser to the US government.

The claim that genetically engineered food grown in the North will help to feed the hungry in the South ignores these dynamics of the global trade in foodstuffs.

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Watkins, K., "Free Trade and Farm Fallacies", *The Ecologist*, Vol.26, No.6, November/December 1996, p.246.

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Box2

The Politics of Hunger

By casting starvation as a problem of food shortage, proponents of genetic engineering offer a seductively simple, but false, analysis of world hunger.

Hunger has seldom been the result of an aggregate shortage of food; instead it has consistently been one of inequalities in political and economic power.

Hunger, as economist Amartya Sen points out, is the inevitable outcome of the normal workings of a market economy.

In his classic text, *Poverty and Famine*, Sen stresses that the famines which decimated peasants in India in 1943 and in Ethiopia, the Sahel and Bangladesh in 1974 were not the result of market failures, but of those market and non-market mechanisms (including the ownership of resources) which undermine the ability of poorer sections of the community to buy goods on the market.

Food goes to those who have the money to buy it. Only those who have the income to translate their biological needs into "effective demand" get to eat.

In today's global supermarket, people earning $25 a year - if they are lucky - must compete for food with people in the same or other countries who earn $25 a hour, or even $25 a minute.

In Costa Rica, for instance, while beef production doubled between 1959 and 1972, per capita beef consumption in the country fell from 30 pounds to less than 19. The reason? US consumers could pay higher prices for the meat than Costa Ricans.

It is this market logic that explains why 20 per cent of parents and 10 per cent of children in Britain experience "food poverty"; why Ethiopia was using some of its prime agricultural land at the height of the 1984 famine in the Horn of Africa to produce linseed cake, cottonseed cake and rapeseed meal for export to Britain and other European nations as feed for livestock; and why insufficient food is a perennial feature of life for an increasing number of people.

Genetic engineering in agriculture does not address these underlying structural causes of hunger (a fact which Monsanto often acknowledges in its PR material). Critically, however, by squeezing the livelihoods of many small and medium-sized farmers, genetically-engineered crops are likely to *strengthen* these causes by increasing landlessness, underemployment and unemployment.

References:

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Rifkin, J., *Beyond Beef: The Rise and fall of the Cattle Culture*, Penguin, New York, 1992;

Drèze, J., Sen, A. and Hussain, A., (eds.) *The Political Economy of Hunger*, Clarendon, Oxford, 1995.

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Box3

Haven't We Been Here Before? The Green Revolution

In seeking to harness public concerns over world hunger in order to promote new (and untried) agricultural technologies, the genetic engineering industry is going over well-trodden ground.

The claims made for the gene revolution echo those made for the Green Revolution - increased food production from new seed varieties with world hunger becoming a thing of the past.

In the early 1960s, for example, the agrochemical industry, backed by the United Nations Food and Agriculture Organisation (FAO), raised the spectre of increased famine and malnutrition in order to push governments and farmers into intensifying agriculture. Then as now, projected increases in world population were used to argue for massive increases in output; then as now, new technologies were hailed as the "only practical solution"; then as now, the structural causes of poverty and hunger were downplayed or ignored; and, then as now, the myriad ways in which production could be increased using labour-intensive, organic methods of agriculture were steadfastly ignored.

The FAO launched the so-called Green Revolution - an ambitious programme aimed at intensifying production through the use of chemical pesticides, fertilisers and "high-yielding" hybrid crops; raising farm income by encouraging farmers into the world market; and promoting export crops to facilitate economic modernisation. Addressing the FAO in 1974, Dr. Henry Kissinger, then US Secretary of State, promised: "Within a decade, no man, woman or child will go to bed hungry."

Although the Green Revolution undoubtedly increased food production, it singularly failed to address the problem of world hunger. Some 35 years after the Green Revolution was launched, there are more people starving today than at any time in human history - despite world cereal yields consistently outstripping world population growth since 1980 (rising by about 2.2 per cent a year compared to a population growth rate of 1.7 per cent). In India, for example, wheat yields were raised by 50 per cent and rice yields by 25 per cent: yet the numbers living in absolute poverty have continued to increase.

At the farm level, the introduction of Green Revolution technologies compelled farmers to buy in chemical applications and hybrid seeds. Sooner or later, many farmers - faced with rising input costs (in part the result of diminishing returns on fertilisers and pesticides) and declining prices for agricultural

produce - found themselves trapped in a cost-price squeeze which eventually forced them out of business. As one farmers' organisation points out:

"Experience has shown repeatedly that when subsistence farmers are offered packages of new seeds and inputs, along with credit to buy them, a large number find they cannot make enough money from their small units to service the debts they have been encouraged to take on. All too frequently, they are forced to sell up so their debts can be paid and their lands are bought up by a new breed of commercial farmers, ambitious to expand and able to invest in machinery and dispense with manual labour."

Today in India, the numbers of farmers committing suicide is growing all the time as more and more indebted, despairing rural dwellers are driven to the wall.

The effects of more than three decades of Green Revolution agriculture have been clear for some time: pesticide and herbicide poisoning of people, animals, soil and water; soil erosion and land degradation; loss of genetic diversity; profits for the few, bankruptcy and landlessness for many; replacement of local economies and farming techniques with an export crop economy.

Indeed, the Green Revolution has done much to intensify and extend hunger's grip, strengthening the very economic and social forces that deny food to poorer people. These impacts will not be lessened with the gene revolution in agriculture, but deepened and expanded.

References:

Smart Plants: A Farmers' Guide to Genetically Modified Organisms (GMOs) in Arable Agriculture, Farmer's Link (49A High St, Watton, Thetford, Norfolk IP25 6AB, UK), 1998.

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Box4

Increasing Landlessness

Without land on which to grow food, genetically engineered or not, many people in the countries of the South are likely to go hungry. The high input costs of genetically engineered crops for many farmers is likely to drive them into debt and bankruptcy and ultimately landlessness.

Today in the Philippines, nearly three-quarters of rural households (three-fifths of the Philippine population) are landless or near-landless.

In Costa Rica, a country where the cattle owned by 2,000 politically-powerful ranching families occupy more than half of the nation's arable, most fertile land, the figure is 55 per cent.

In Guatemala, huge swathes of land owned by the biggest landlords - an estimated 1.2 million hectares - lie idle, either because the price of export crops is too low to justify planting or because the land is being held for speculation. Some 310,000 people over 20-years of age are landless and without permanent employment.

Even where people have nominal access to land, this hold is often insecure. In many countries of the South, for instance, women do not have legal land titles to the land they cultivate. Discriminatory legislation and practices concerning inheritance, access and ownership are still widespread. Land that women do own tends to be the smaller, less valuable plots.

This is not a trivial issue given that, according to the UN's Food and Agriculture Organisation, women produce more than half of all the food that is grown in the world. In sub-Saharan Africa and the Caribbean, they produce up to 80 per cent of basic foodstuffs. In Asia, they provide from 50 to 90 per cent of the labour for rice cultivation. In South-East Asia, the Pacific and many Latin American countries, women's home gardens represent some of the most complex agricultural systems known.

Across much of the developing world, rural women provide most of the labour for farming, from soil preparation to harvest. After the harvest, they are almost entirely responsible for storage, handling, stocking, marketing and processing.

Many development and welfare programmes (and any policies to encourage women to grow genetically-engineered crops) which focus on meeting women's "basic needs", attempting to provide access to education, health care and food, fail to question the distribution of productive resources and political power, and the social division of labour by gender, caste and class.

Landlessness and hunger go hand-in-hand. Eight out of ten farmers in Central America do not have enough land to sustain their families, forcing them to look for seasonal jobs. In Guatemala, government figures from the mid-1980s estimated that 86 per cent of families were living below the official poverty line, with 55 per cent classified as "extremely poor". Rates of malnutrition reflect these figures.

If land reform were to be carried out in Egypt, a country dominated by large landholdings, by setting a ceiling on landholdings at just over three acres (almost five times the minimum required to support a family) landlessness and near-landlessness could be eliminated. Total agricultural production might also increase, as small landholdings produce higher yields per acre than large ones.

In many places, large-scale commercial farms tend to be on the best agricultural land. The sale of their produce is often controlled by national and transnational interests whose profits do not usually go towards feeding the hungry. In Brazil, more land is owned by multinationals than all the peasants put together. Most of the TNC land is used to grow cash crops for export abroad.

Over half of all fruit exports from Chile, now the largest supplier of off-season fruits and vegetables to Europe and North America, are controlled by five transnational companies. In Africa, the rapid expansion of fruit and vegetable exports is dominated by foreign transnational companies (in the case of Kenya and Zambia, for instance) or by powerful domestic commercial interests (in the case of Zimbabwe). The concentration in control over production and marketing means that the benefits from international trade are also highly concentrated.

In Sudan, the expansion of large mechanized farms has not brought cheap grain to many areas of the country because the food is largely exported. Moreover, some 90 per cent of Sudan's marketable food surplus was controlled by less than one per cent of farmers by the end of the 1980s.

While famines occurred in the Sahel countries of Burkina Faso, Mali, Niger, Senegal and Chad in the mid-1980s, these countries produced record harvests of cotton for export to industrialised countries.

If people are hungry because they do not have land on which to grow food, either for themselves or to sell, genetically engineered food crops will do nothing to lessen their hunger - they may well exacerbate their problems.

References:

Bina Agarwal, *A Field of One's Own: Gender and Land Rights in South Asia*, Cambridge University Press, New York, 1995.

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Box5

Increased Yields?

Although proponents of genetic engineering in agriculture promise "a second revolution in food production", arguing that biotechnology "holds out our greatest hope of dramatically increasing yields", experience to date suggests otherwise. The genetically-engineered crops now being cultivated have not significantly increased yields. In some cases, yields are lower than those for conventional varieties of the same crop.

In the first large-scale field trials in Puerto Rico in 1992 of Roundup Ready plants, Monsanto scientists found statistically significant *reduced* yields, averaging some 11.5 per cent, in three of seven trials.

Many of the first growers of Roundup Ready cotton in the Mississippi Delta of the US complained in 1997 of low yields and poor quality, noting that bolls dropped prematurely and were deformed. Over 50 growers filed complaints with the newly-formed US Seed Arbitration Council; Monsanto has since paid out substantial
compensation.

Writers Marc Lappé and Brit Bailey report that in 30 out of 38 tests, Roundup Ready soybeans yielded nearly 10 per cent less than conventional soybeans. In another four cases, the yield of the Roundup Ready crop could do no better than match the yields of the highest yielding conventional soybean appropriate for the region.

The gap may be even wider where conditions are not ideal. Several analysts conclude that "any further increases in crop yields in modern food crops will almost certainly come from building on traditional breeding methods - not from transgenics".

Claims that the current generation of genetically-engineered crops will increase yields also need to be set against predictions of the food that is likely to be lost as a result of the use of the new technologies, particularly those that require the use of herbicides.

In Southern countries, for example, much of the output from household plots comes in the form not of cultivated crops but of uncultivated "weeds".

As Vandana Shiva of the Delhi-based Research Foundation for Science, Technology and Ecology comments:

"In West Bengal, 124 'weed' species collected from rice fields have economic importance for local farmers. In a Tanzanian village, over 80 per cent of vegetable dishes are prepared from uncultivated plants."

Were farmers in these regions to adopt genetically-engineered herbicide tolerant crops, their harvest of uncultivated plants would cease, since the herbicides would destroy the "weeds". In many cases, the result would be a severe reduction in the availability of food - particularly for poorer people.

Rice paddies have also customarily provided fish, shrimp, crabs, edible herbs, frogs and medicines. The loss of such complementary harvests necessitated by the use of pesticides and herbicides is seldom taken into account when yields of Green Revolution - or genetically-engineered - crops are calculated.

References:

Lappé, M. and Bailey, B., *Against the Grain: The Genetic Transformation of Global Agriculture*, Earthscan, London, 1998;

Shiva, V., *Betting on Biodiversity: Why Genetic Engineering Will Not Feed the Hungry*, Research Foundation for Science, Technology and Ecology, New Delhi, 1998;

Rissler, J. and Mellon, M., *The Ecological Risks of Engineered Crops*, The MIT Press, 1996.

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Box6

Monocultures, Pests & Genetically-engineered Crops

It is estimated that between 10-40 per cent of the world's gross agricultural production is lost to pests, weeds and disease. The British Agrochemicals Association puts the figure higher, claiming that

"on average, the farmers of the world lose between 30 and 50 per cent of their own crops before harvest. In other words, for every three loaves of bread which could be produced, more than one is lost because of pests."

By far the highest losses are on farms where crops are grown in monocultures - the cultivation of a single crop over large stretches of land - and regularly sprayed with chemicals.

Not only do monocultures greatly increase the food supply for specific pest populations but, if crops are not rotated, they create a permanent niche for the pests. Indeed, it is now acknowledged by agricultural experts that the principal cause of crop losses due to pest damage is monoculture agriculture. As the UN Food and Agriculture Organization (FAO) puts it:

"Pressure from animal pests, diseases and weeds is higher in areas where the same crop is grown all year round."

The problem is compounded, according to FAO, by the use of modern seed varieties which "are often more susceptible to pest damage" and, ironically, by the use of pesticides which:

"can bring about vicious circles of pest resistance, elimination of natural predators, and ever more increased use of and dependence on chemicals."

Because genetically-engineered crops are designed for use within this system of industrial monocultures, they will do nothing to address the root causes of crop losses due to pests. Far from patching up problems such as pesticide resistance, water pollution and soil degradation caused by agrochemicals (chemicals
promoted incidentally by the same companies now advocating genetic engineering), these crops are likely to accentuate them.

Much less of a harvest is lost to pests and disease if several different crops are grown in the same field (intercropping or multiple cropping) and the crops rotated from season to season. In organic farming, pest control also hinges on building up soil, plant and field health.

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This briefing was prepared by The CornerHouse which aims to support the growth of a democratic, equitable and non-discriminatory civil society in which communities have control over the resources and decisions that affect their lives and means of livelihood, as well as the power to define themselves rather than to be defined by others.

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Power Up Your Retirement

PowerUp Your Retirement

Making plans for your retirement should be one of your most important financial considerations. The money you get to save during your working years will provide you with the majority of your income for the remainder of your years, which could be up to age 90 and older.

It's necessary to check on the progress of your retirement plans periodically. You need to ask yourself questions like: Are my savings growing? Have I been reducing my expenses? Are my investments earning enough?

The following web sites were carefully selected to help you better answer these important retirement questions. These resources will show you where you can find the most efficient insurance coverages, when to reduce your mortgage expenses, and how to maximize your real estate and stock investments.

Auto Insurance - Helpful Sites

Auto Insurance Online - Learn, compare, get quotes and buy auto insurance online.

Auto Loans - Helpful Sites

Apply for Auto Loans Online - Financing and refinancing of new or used cars at the lowest interest rates possible with a simple online application.

Auto Loans - Quick 60-second online auto loan application, no obligation required

Car Loan Financing - Online car financing for people with all credit situations, we can overcome most credit problems.

Car Loans - Purchase and refinance for people with excellent or bad credit.

General Insurance - Helpful Sites

Advocates for the Insured - This website provides information and services to anyone making claims against their insurance policy or any most other type of claims.

all insurance information - Online insurance information guide is a free information service so consumers can make wise decisions concerning insurance and getting insurance quote information.

Employee Benefits, Insurance and Investments - Best Plans - Canadian brokers provide free quotes for group health, dental, insurance & group RRSP pensions plans.

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Rick Young Insurance & Associates - Rick Young & Associates offers a wide range of plans to meet the needs of Michigan's Health Insurance and Michigan's Medical Insurance customers.

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Investing - Helpful Sites

A-Z Free Investment Data - Free stock market and mutual fund information, free RRSP information, free Canadian and United States stock quotes, investing data, and glossary of financial terms.

Fundraising for Associations, Non-Profit Organizations and Charities - Professionals at AffiliateInsurance.com create an ongoing non-dues revenue stream for associations, non-profit organizations and charities with our benefits affiliate programs.

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Mortgage Services - Helpful Sites

ABC Finance Pty Ltd. - Rebate Home Loans are available from us. We pay mortgage refunds to clients in the Sydney, Melbourne, Brisbane and Newcastle regions. This website contains loan calculators and other mortgage resources for residents of Australia.

Adverse Credit Mortgages - Choose from over 6000 lenders to find the best deal for your needs, even if you have adverse credit. For UK citizens only.

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RFSTE / Navdanya / DWD events at WSF 2004 (Mumbai)

Peoples World Water Forum 12 - 14 Jan New Delhi

Global Water Warrior Gathering 10th Jan Plachimada, Palakkad, Kerala

Water March (Jal Yatra) to Tehri / Ganges and Narmada

Prince Charles visit to Navdnaya's Organic Outlet

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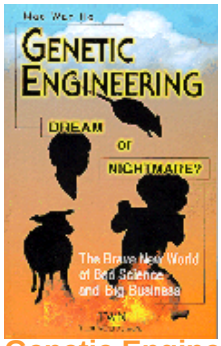
Recommended

Model National Biosafety Law
by GS Nijar/TWN

"... nations of the South are increasingly faced with the prospect of the introduction into their countries of genetically modified organisms (GMOs) and products derived from GMOs...with countries seeking to put in place national laws, this model law has been drafted to present one possible option."

See also:

An introduction to the model national law on biosafety
- This provides an intro to the model law and lists its basic scheme



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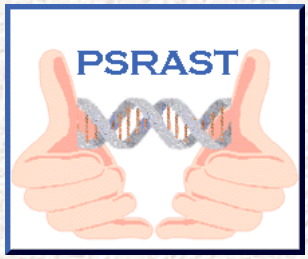

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YOU can get the "Genetically Engineered Food Right to Know Act" passed into law!

Simply follow the Three Basic Action Steps listed below. Also consider taking some of the Advanced Action Steps.

Three Basic Action Steps

Step Number One: Mail a letter to your U.S. House Representative asking him or her to co-sponsor bill HR 2916, the "Genetically Engineered Food Right to Know Act." We have created a form letter for you. All you need to do is print it out and mail it to your Representative's Washington, DC office, via the U.S. Postal Service.

Step Number Two: Print out at least 10 additional form letters and give them to your friends and associates to mail to their Representative.

Step Number Three: Go to our Tell A Friend web page and send an e-mail message to your friends and associates that informs them about this web site and asks them to mail a letter to their U.S. House Representative.

The only thing stopping the Genetically Engineered Food Right to Know Act from being passed into law is that members of the U.S. Congress need to hear from many more concerned citizens like you.

Want to do more than the Three Basic Action Steps? Read on....

Advanced Action Steps

Click on any of the links in blue lettering to go to a web page that will provide more information about that topic.

Send letters to Senators: The "Genetically Engineered Food Right to Know Act" has not yet been introduced into the U.S. Senate. It is expected that Senator Barbara Boxer (D-CA) will introduce it into the Senate when the House of Representatives version gathers enough co-sponsors. It is great to send letters now to your two Senators

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Join the Save Organic Food Coalition: Help stop the contamination of organic food from the cross-pollination from genetically engineered crops. Put press pressure on Congress to hold hearings on the contamination of organic crops.

Activist Action Steps

If you want to really make a difference in your community and state, then consider taking one or more of these Activist Action Steps.

Table at events: It is amazing how many signed form letters one person can get from people in just a few hours at a public event. Just set up a card table in an area where there are a lot of people walking by and have form letters available for people to sign.

City or County Council Resolution: Approach a member of your City or County Council to introduce a Resolution that states that your municipality supports the "Genetically Engineered Food Right to Know Act."

State Bill: Approach a member of your state legislature to introduce a state bill requiring labeling of genetically engineered foods in your state.

Forum Discussions: Share your successes and ideas with others by posting messages to our Forums.

Become An Activist Contact: You can sign up to become an Activist Contact for your state. To be listed, you should be actively involved in recruiting others in the effort to label genetically engineered foods.

Hold a Public Presentation: You may wish to hold a public presentation to inform folks in your community about the issues surrounding genetically engineered foods. Each state listing has a calendar where you can post such events.

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The Coordinating Council

The Coordinating Council

The Campaign Canada

The Campaign to Label Genetically Engineered Foods

Visit Your House Representative or Senator: Your elected officials often hold public events where folks have the opportunity to ask them questions or make suggestions. Attend one or more of these meeting to let your requests for labeling of genetically engineered foods be known.

A brief word about terminology

Analysts use many different phrases to describe genetically engineered foods. The biotech industry rarely uses the phrase "genetically engineered foods," sticking with the more bland (and less controversial) phrase "biotech foods."

In Europe, genetically engineered foods are more commonly referred to as genetically modified foods, genetically altered foods or GMOs (short for genetically modified organisms). But scientists generally agree that "genetically engineered" more accurately represents the process than "genetically modified."

Supporters of biotech foods often try to argue that we have been genetically modifying our foods for centuries, through a process known as hybridization, or interbreeding. But that process is far different than the recombinant DNA splicing used in modern agricultural biotechnology.

It is interesting to note that the new eleventh edition of the Merriam-Webster Collegiate Dictionary added the word "Frankenfood" as another term to describe genetically engineered food.

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PROFILE

Against the Grain

Why poor nations would lose in a biotech war on hunger

by Marilyn Berlin Snell

Biotechnology has been heralded as a boon to developing countries, where the lion's share of the world's hungry dwell. Its breakthroughs--food crops genetically engineered to resist disease, pests, and drought, or to contain vitamins and nutrients severely lacking in the diets of the poor--are seen as a 21st-century version of the Green Revolution of the 1960s and '70s, when hybrid crop varieties and heavy use of fertilizers and irrigation boosted yields 20 to 30 percent. The promise of more abundant and more nutritious food appears to hold out the hope that hunger and disease can be alleviated. With potential like this, who wouldn't be in favor of genetically engineered crops?

For starters, many of the people they are supposed to help. One of the strongest and most articulate voices to emerge in opposition to biotechnology is Tewolde Berhan Gebre Egziabher (formally addressed, as is Ethiopian custom, as Tewolde). Born to a peasant farming family in northern Ethiopia in 1940, Tewolde worked as a plant ecologist and university president before becoming the head of Ethiopia's Environment Protection Authority in 1995. Concerned with the impact that unregulated biotech products could have on the rich biodiversity of the developing world, and also with how the plight of hungry people was being used to promote genetic engineering, Tewolde has been a key international negotiator on issues of biotech safety and accountability. He helped hammer out the United Nations Convention on Biological Diversity and draft the Biosafety Protocol, which if ratified will set international standards for trade in and use of biotech products. During the protocol talks, the U.S. delegation heavily influenced the discussion--often bolstered by agricultural allies like Canada and Australia. The meetings were heated and often acrimonious, with the United States and its friends at one end of the spectrum, arguing that genetically modified organisms do not need special regulations, while Tewolde and the majority of participating nations argued that they most certainly do.

Since 1999, Tewolde has represented what has come to be called the Like-Minded Group--made up of most developing nations plus China--in protocol negotiations and at World Trade Organization meetings. Two of the most important issues debated at these meetings have been whether a country has a right to know what it is importing, and whether a government has a right to refuse an import it believes endangers its population. As drafted, the Biosafety Protocol now states that nations have such rights. The next step is ratification by at least 50 nations and ensuring that the

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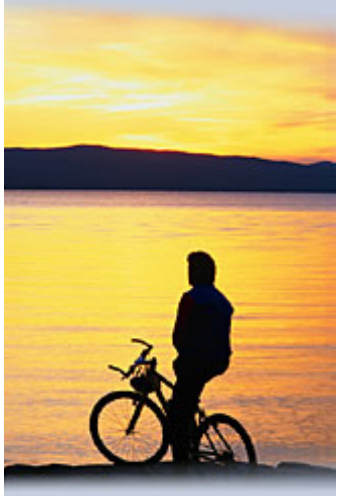

WTO or other international bodies cannot overrule the protocol.

In April Tewolde spoke with Sierra about his ongoing fight on behalf of the environment and the poor, and how it feels to butt heads with a superpower.

Sierra: Biotechnology proponents argue that biotech crops that resist pests and increase yields provide a solution to grave problems such as hunger and malnutrition. How do you respond?

Tewolde: First, to my knowledge there has not been one commercially grown transgenic crop that out-yields all other varieties of that crop. Genetic engineering may live up to this promise, but we will have to see. What the transgenic crops have done so far is tie the farmer to specific chemicals and a specific company.

That said, this notion that genetically engineered crops will save developing countries misses the real point. The world has never grown as much food per capita as it is doing now, yet the world has also never had as many hungry. The problem is not the amount of food produced, but how it is both produced and distributed. For example, farmers in developing countries who buy genetically engineered seeds that cannot reproduce--and so can't be saved and used for next year's crop--become tied to transnational companies like Monsanto.

As it stands, the political and economic problems within our developing countries prevent us from using existing technologies that are under our control. For example, in 1981, the Lonrho Company was allowed to freely plant trees in Swaziland while the people had to get a special permit to plant any tree. And it continues to be the case that in many countries of the South, individual landowners keep big tracts of land uncultivated while many hungry citizens cannot grow food because of lack of land.

How much more difficult is it going to be to use technology that is controlled from another country? Let me give an example: Ethiopia just had a war with Eritrea that provoked a trade embargo. I'm not complaining about the embargo; I wish we had never made any war. But suppose we had become dependent on some crop variety from the United States, Japan, or Kenya? What if, during this political fracas, our trading partners had said, "No more seed"? What then?

The biotech industry is suggesting that food security will come through the farmer's loss of control of essential agricultural inputs. Do you see the lie? This is food insecurity. Even if genetic engineering managed to double, triple, or quadruple food production, it would still remain an irrelevance. Genetic engineering can't help here, unless we can engineer people who can think straight and be decent.

I don't trust the government. I don't mean particularly the Ethiopian government--I mean any government. Without local control, local availability of food can never be certain. It would be far better to develop a system that would enable the farmer himself to be in charge. I know it sounds remote in the United States to think of a breakdown of law and order, but in Africa there are many politically unstable countries. If every time there was a breakdown of law and order, the system of food production were to suffer, it could mean death to millions.

Sierra: It sounds almost as though you see genetic engineering as

the seed of something evil.

Tewolde: It's not the nature of genetic engineering itself that's the problem; it is the way genetic engineering has evolved. Early on, it came under the control of the private sector and is now being developed almost solely by that sector. By definition, the private sector's goal is to make money. It will not focus its attention on the needs of the poor, except as a way to sell its products.

Sierra: Beyond the political and economic issue of who controls the products of biotechnology, do you see any other threats to the South?

Tewolde: Let me begin by stressing that the threat is not only to the South; it is to life as a whole. The major threat is that we are combining genes that have not previously been combined. We are creating new traits and we simply don't know what could happen. We must be careful not to make major mistakes.

There are, however, some threats that are more specifically amplified in the South, arising from three factors. One is that there is a lot more biodiversity toward the equator, which means that the variables and possible complications increase. The second factor has to do with the ambient temperature: In the tropics, the temperature outside is nearer to the temperature of containment in laboratories. This means that those transgenic organisms that accidentally escape to the open environment have a greater chance of survival. The third factor relates to genetic engineering's current emphasis on crops. The gene pool of most of these modified crops exists in unadulterated form in tropical and subtropical areas. Take barley, for example. Ethiopia has the largest gene pool for cultivated barley anywhere in the world. Canada grows barley, but there is no native barley there. Should a genetically engineered variety go wrong and escape into the environment, Canada can start over again and develop a new variety--forgetting about all the varieties it has contaminated and destroyed. But if that were to happen in Ethiopia, the native gene pool--including wild relatives of crop plants--could be polluted. Such mistakes could never be undone.

There is an additional element that is not biological in nature. Economically, the countries closer to the equator are much poorer than the industrialized countries, and therefore lack the resources to deal with these sorts of mistakes.

Sierra: How did you first get involved in issues relating to biotechnology?

Tewolde: In the 1980s I was president of a university and also in charge of a few research projects. In 1989, I started leading a project to identify environmental problems and to suggest strategies to try to harmonize environment and development in Ethiopia. Around this time, the Rio Conference was gearing up, so I became involved in negotiating the proposed text of the 1992 biodiversity convention. Then, at the Earth Summit, two other issues came to the fore that really helped galvanize my thinking.

The first was the insistence of the U.S. delegation on intellectual property rights, while refusing to see that communities--indigenous communities that are not well versed in biological theory--have rights that must be respected as well. The second had to do with the U.S. delegation's insistence that genetic engineering is the same as any old sexual reproduction, and therefore did not need to be regulated. This came to be known as "substantial equivalence," in

which sexual reproduction--where a man and a woman meet, mate, and their genes mix--is essentially the same as mixing genes from a tobacco plant and a firefly.

I opposed this idea of substantial equivalence. There was a lot of arguing about this in the convention negotiations. Finally, it was agreed that the parties would examine if there were a need for a protocol on safety in modern biotechnology. That's where we had to start, because opposition to regulation was so fierce. Most nations wanted a biosafety protocol, but a few powerful nations were totally opposed. I was part of the group that wrote what was called a majority report, saying that there was a need for a protocol. The minority report, that of the U.S. delegation, essentially said there was no need at all. Many of its delegates even used the argument that the majority report came from developing countries whose science is dubious. Fortunately, we had U.S. scientists from various universities testify that there is a risk.

Sierra: It's difficult to imagine that the U.S. delegation would challenge your science in such a way.

Tewolde: But that's the usual argument! The delegates don't say it in the meetings. Most of these negotiations happen in the corridors anyway. You lobby some delegation and say "You know what? So and so was saying that the other side's data is rubbish." It's standard negotiating practice. Even so, after we presented the majority group report, our battle was won. At that point, the ad hoc working group said that there should be a protocol, and the next phase of the negotiations began.

Sierra: Because the U.S. Congress in the end refused to ratify the Rio Convention on Biological Diversity, it now has only "observer status" in negotiations on how to implement the protocol, correct?

Tewolde: That's right. However, the United States does claim to support the convention. So presumably the United States would continue to be supportive of the protocol as well--but for practical reasons now: If its laws on genetic engineering do not conform to the protocol, countries will refuse to trade with it in genetically modified organisms.

When the protocol comes into force, the first issue it will handle is the labeling of all genetically modified organisms. At the moment, all the document says is that if a country is exporting genetically modified organisms, it must say "it may contain," which is not very informative. That was a point on which the protocol negotiations nearly collapsed at the Montreal meeting in January 2000. The degree of labeling is an issue that is still unresolved.

Sierra: Some observers have noted that even with the Biosafety Protocol in place, refusing genetically modified imports will be significantly more difficult for developing countries because they have much more to lose in financial aid and other arrangements. What are the costs for a country like Ethiopia in saying no to these types of imports?

Tewolde: If the United States were to disregard the Biosafety Protocol and intimidate poor countries into accepting genetically modified organisms, quite a few of them would probably accept. But one expects that a respectable government, such as the one in the United States, will honor laws--even if they are not their laws.

This will sort itself out. In the transition period though, products that wouldn't sell in Europe or Japan will probably be pushed on us.

Especially with regard to food aid, I expect this is already happening. Obviously, it is an extremely difficult situation if you know people are dying from lack of food and the only food you are offered is genetically engineered. [According to the U.S.-based Institute for Food and Development Policy, more than 2 million tons of genetically modified organisms are sent directly by U.S. foreign assistance to developing countries each year, while the World Food Program distributes another 1.5 million tons of transgenic crops donated by the U.S. government. The food is typically sent with no labeling. --eds.]

Sierra: The Like-Minded Group, which you represent in international negotiations, has championed the "precautionary principle" as a way to address issues of biosafety. How would you define this principle?

Tewolde: The simplest way to state it is that you must evaluate risks before you take them. That does not mean "do not take any risks at all," though this is very often what people who want to distort its meaning suggest. It means, rather, that if you must take a risk in the absence of knowledge you should err on the side of caution and say, "until I know, I won't do this."

Sierra: How do you respond to critics who say the precautionary approach is little more than technophobia?

Tewolde: I'm not saying that there are not people who use it in that way. But, as a scientist, I take it to mean that if I am making a decision I should not make one from a position of "not knowing." In our daily lives, most of us operate from this perspective. If you want to jump into a pool, for example, you first estimate how deep it is so that you don't break your neck. You always observe and evaluate before you take that fateful step. That, in essence, is the precautionary principle.

Sierra: It sounds like a good idea. Why is it so difficult to adhere to at the global level?

Tewolde: At the global level, the principle is invoked to protect society, not the individual. Society and the individual are not necessarily the same. Often, the individual--and here I include corporations--has to be tamed to make society possible. That's why we have the law. One problem with the present push toward globalization is that it is focused only on the rights of the individual or the state--both of which are capable of somewhat capricious actions. I hope you will pardon me, but I'd also add that the more influential governments are now really largely run by individuals who represent corporate interests. I think genetic engineering is really going wild because it is not controlled by society but by selfish individual interests.

Sierra: That was actually my next question--what you thought the preeminent motives driving the U.S. delegation have been.

Tewolde: I'm glad you asked, because I was a bit apprehensive to talk about what I see as the corporate control of government. When I am in negotiations with the United States, Canada, and Australia, though, corporate control is clear.

Sierra: You're suggesting that in these negotiations you're essentially dealing with a multinational corporation rather than a government?

Tewolde: No. It is a government but corporate interest is top on its agenda. Given the arguments put forward by these governments,

this conclusion is the only one that makes sense. I know the individuals who are making these arguments. They have deep scientific knowledge. But then they argue that genetic engineering and sexual reproduction are essentially the same. The only explanation I have is that they don't want to regulate genetic engineering. And, if they don't want to regulate genetic engineering, one must ask why. Who benefits?

Sierra: How has it been for you to go up against the United States in negotiations?

Tewolde: If you mean do I get intimidated, I don't. I have nothing vested that I have to protect. I have only my conscience to negotiate with. I have been insulted. I have been threatened. I just shrug my shoulders. It doesn't matter. Let me be clear here, though: I'm not referring to the negotiators. I have never had any negative reaction from the negotiators, American or otherwise. I am referring to corporate representatives who come into those meetings. They come as observers and we meet and interact informally. They don't negotiate, though sometimes governments name people from various corporations as members of their delegations.

Sierra: What role has public opposition to genetic engineering played in these high-level negotiations?

Tewolde: Public opinion has played a most critical role in the negotiations on biosafety. In 1999, in Cartagena, Colombia, the group led by the United States refused outright to consider any form of regulations of commodities that are genetically modified. The next move by this group was the United States and Canada tried to introduce the issue about genetically modified commodity regulation into the WTO negotiations in Seattle in December 1999. But, as you know, public opposition and opposition from within by developing countries forced that effort to collapse. It was only because that happened in Seattle that the negotiations in Montreal last year succeeded. The U.S. group felt it had to back down on most of the issues.

Sierra: Whose voice will ultimately prevail on this issue?

Tewolde: The people's voice. If the people are convinced it is important, they will refuse to buy corporate products that have been genetically engineered. If corporations want a market, then they will have to go along with what the public requests.

Marilyn Berlin Snell is *Sierra*'s writer/editor.

Up to Top

Monday, 25 June, 2001, 16:47 GMT 17:47 UK

World food 'under threat'

Food security depends on relatively few crops

Environmental groups said on Monday that patenting by multinational corporations threatened food security and access by farmers to vital genetic resources.

And they argued US efforts to block a new worldwide treaty on plant genetics would be every bit as damaging to life on Earth as Washington's refusal to implement the Kyoto Protocol on climate change.

The criticisms were made in Rome where representatives from 160 governments are trying to get a binding global agreement that will govern the use of crop seed varieties and genetic resources.

The number of crop varieties grown by farmers has plummeted by more than 75% over the past 100 years, as super strains have come to dominate the global market.

WTO rules

This has increased the vulnerability of modern crops to major outbreaks of pests and diseases, which in turn has made the genetic diversity offered by older breeds highly valuable.

A meeting of the Commission for Genetic Resources for Food and Agriculture, part of the United Nation's Food and Agriculture Organisation (FAO), is discussing a proposal to safeguard this gene pool for the future, by making seeds in seed banks available to all who need them.

The proposed treaty would give credit to peasant farmers who developed the crops in the first place and force firms using genetic material from the seed banks to pay a levy to promote crop diversity in developing countries.

Most nations support the treaty, but the US is voicing strong opposition, along with Canada and Australia. Opponents believe there should be no restrictions on the "right" to patent genetic resources and that, in any case, this whole area should come

Patent debate
Patrick Mulvany and Professor Vivian Moses disagree on intellectual property rights
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under the World Trade Organisation and not the UN.

Patent progress

Patrick Mulvany, who advises the charity the Intermediate Technology Development Group, said: "This treaty will safeguard the materials that underpin food security.

"There are about 100 crops that provide this security and what we believe - environment and development organisations and farmers' organisations - is that there are a few countries that want to undermine this treaty that would keep these crops free from intellectual property rights and in the public domain for perpetuity."

Professor Vivian Moses, who chairs the UK probiotech group CropGen, said the environmentalists had once again overstated their case.

"One ought to recognise that patents are a very important way of making progress and patents can only be applied to novelties, to new products which are new inventions which are useful and are workable.

"And remember that you have to disclose any information about a new patent - so any advantage that you may have had by keeping the information secret is lost when you patent. Anyone else can then use that information for their own developments that may outflank your patent."

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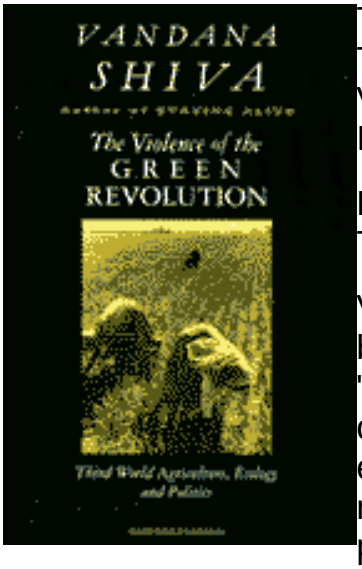

The Violence of the Green Revolution
Third World Agriculture, Ecology and Politics
Vandana Shiva Third World Network and with ZED Books
ISBN; 983-99573-8-4 (Hb.) 983-99573-9-2 (Pb.) 264 pages, 14-21.5cm

Paperback: US$15.00
Third World: US$10.00 (paperback)

Vandana Shiva examines the impact of the first Green Revolution on the breadbasket of India. In a cogent empirical argument, she shows how the "quick fix" promise of large gains in output pushed aside serious pursuit of an alternative agricultural strategy grounded in respect for the environmental wisdom of peasant systems and building an egalitarian, needs-oriented agriculture consistent with the village-based, endogenous political traditons of Gandhism.

Dr. Shiva documents the destruction of genetic diversity and soil fertility that resulted, and in highly orginal fashion shows how the Green Revolution also contributed to the acute social and political conflicts now tearing the Punjab apart.

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Do We Need New Technology to End Hunger?

Faced with an estimated 786 million hungry people in the world, cheerleaders for our social order have an easy solution: we will grow more food through the magic of chemicals and genetic engineering. For those who remember the original "Green Revolution" promise to end hunger through miracle seeds, this call for "Green Revolution II" should ring hollow. Yet Monsanto, Novartis, AgrEvo, DuPont, and other chemical companies who are reinventing themselves as biotechnology companies, together with the World Bank and other international agencies, would have the world's anti-hunger energies aimed down the path of more agrochemicals and genetically modified crops. This second Green Revolution, they tell us, will save the world from hunger and starvation if we just allow these various companies, spurred by the free market, to do their magic.

The Green Revolution myth goes like this: the miracle seeds of the Green Revolution increase grain yields and therefore are a key to ending world hunger. Higher yields mean more income for poor farmers, helping them to climb out of poverty, and

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more food means less hunger. Dealing with the root causes of poverty that contribute to hunger takes a very long time and people are starving now. So we must do what we can-increase production. The Green Revolution buys the time Third World countries desperately need to deal with the underlying social causes of poverty and to cut birth rates. In any case, outsiders-like the scientists and policy advisers behind the Green Revolution-can't tell a poor country to reform its economic and political system, but they can contribute invaluable expertise in food production. While the first Green Revolution may have missed poorer areas with more marginal lands, we can learn valuable lessons from that experience to help launch a second Green Revolution to defeat hunger once and for all.

Improving seeds through experimentation is what people have been up to since the beginning of agriculture, but the term "Green Revolution" was coined in the 1960s to highlight a particularly striking breakthrough. In test plots in northwest Mexico, improved varieties of wheat dramatically increased yields. Much of the reason why these "modern varieties" produced more than traditional varieties was that they were more responsive to controlled irrigation and to petrochemical fertilizers, allowing for much more efficient conversion of industrial inputs into food. With a big boost from the International Agricultural Research Centers created by the Rockefeller and Ford Foundations, the "miracle" seeds quickly spread to Asia, and soon new strains of rice and corn were developed as well.

By the 1970s, the term "revolution" was well deserved, for the new seeds-accompanied by chemical fertilizers, pesticides, and, for the most part, irrigation-had replaced the traditional farming practices of millions of Third World farmers. By the 1990s, almost 75 percent of Asian rice areas were sown with these new varieties. The same was true for almost half of the wheat planted in Africa and more than half of that in Latin America and Asia, and about 70 percent of the world's corn as well. Overall, it was estimated that 40 percent of all farmers in the Third World were using Green Revolution seeds, with the greatest use found in Asia, followed by Latin America.

Clearly, the production advances of the Green Revolution are no myth. Thanks to the new seeds, tens of millions of extra tons of grain a year are being harvested. But has the Green Revolution actually proven itself a successful strategy for ending hunger? Not really.

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Narrowly focusing on increasing production-as the Green Revolution does-cannot alleviate hunger because it fails to alter the tightly concentrated distribution of economic power, especially access to land and purchasing power. Even the World Bank concluded in a major 1986 study of world hunger that a rapid increase in food production does not necessarily result in food security-that is, less hunger. Current hunger can only be alleviated by "redistributing purchasing power and resources toward those who are undernourished," the study said. In a nutshell-if the poor don't have the money to buy food, increased production is not going to help them.

Introducing any new agricultural technology into a social system stacked in favor of the rich and against the poor-without addressing the social questions of access to the technology's benefits-will over time lead to an even greater concentration of the rewards from agriculture, as is happening in the United States.

Because the Green Revolution approach does nothing to address the insecurity that lies at the root of high birth rates-and can even heighten that insecurity-it cannot buy time until population growth slows. Finally, a narrow focus on production ultimately defeats itself as it destroys the very resource base on which agriculture depends. We've come to see that without a strategy for change that addresses the powerlessness of the poor, the tragic result will be more food and yet more hunger.

More Food and Yet More Hunger?

Despite three decades of rapidly expanding global food supplies, there are still an estimated 786 million hungry people in the world in the 1990s. Where are these 786 million hungry people? Since the early 1980s, media representations of famines in Africa have awakened Westerners to hunger there, but Africa represents less than one-quarter of the hunger in the world today. We are made blind to the day-in-day-out hunger suffered by hundreds of millions more. For example, by the mid-1980s, newspaper headlines were applauding the Asian success stories-India and Indonesia, we were told, had become "self-sufficient in food" or even "food exporters." But it is in Asia, precisely where Green Revolution seeds have contributed to the greatest production success, that roughly two-thirds of the undernourished in the entire world live.

According to Business Week magazine, "even though Indian granaries are overflowing now," thanks to the success of the Green Revolution in raising wheat and rice yields, "5,000 children die each day of malnutrition. One-third of India's 900 million people are poverty-stricken." Since the poor can't afford to buy what is produced, "the government is left trying to store millions of tons of foods. Some is rotting, and there is concern that rotten grain will find its way to public markets." The article concludes that the Green Revolution may have reduced India's grain imports substantially, but did not have a similar impact on hunger.

Such analysis raises serious questions about the number of hungry people in the world in 1970 versus 1990, spanning the two decades of major Green Revolution advances. At first glance, it looks as though great progress was made, with food production up and hunger down. The total food available per person in the world rose by 11 percent over those two decades, while the estimated number of hungry people fell from 942 million to 786 million, a 16 percent drop. This was apparent progress, for which those behind the Green Revolution were understandably happy to take the credit.

But these figures merit a closer look. If you eliminate China from the analysis, the number of hungry people in the rest of the world actually increased by more than 11 percent, from 536 to 597 million. In South America, for example, while per capita food supplies rose almost 8 percent, the number of hungry people also went up, by 19 percent. In south Asia, there was 9 percent more food per person by 1990, but there were also 9 percent more hungry people. Nor was it increased population that made for more hungry people. The total food available per person actually increased. What made possible greater hunger was the failure to address unequal access to food and food-producing resources.

The remarkable difference in China, where the number of hungry dropped from 406 million to 189 million, almost begs the question: which has been more effective at reducing hunger-the Green Revolution or the Chinese Revolution, where broad-based changes in access to land paved the way for rising living standards?

Whether the Green Revolution or any other strategy to boost food production will alleviate hunger depends on the economic, political, and cultural rules that people make. These rules determine who benefits as a supplier of the increased

production-whose land and crops prosper and for whose profit-and who benefits as a consumer of the increased production-who gets the food and at what price.

The poor pay more and get less. Poor farmers can't afford to buy fertilizer and other inputs in volume; big growers can get discounts for large purchases. Poor farmers can't hold out for the best price for their crops, as can larger farmers whose circumstances are far less desperate. In much of the world, water is the limiting factor in farming success, and irrigation is often out of the reach of the poor. Canal irrigation favors those near the top of the flow. Tubewells, often promoted by development agencies, favor the bigger operators, who can better afford the initial investment and have lower costs per unit. Credit is also critical. It is common for small farmers to depend on local moneylenders and pay interest rates several times as high as wealthier farmers. Government-subsidized credit overwhelmingly benefits the big farmers. Most of all, the poor lack clout. They can't command the subsidies and other government favors accruing to the rich.

With the Green Revolution, farming becomes petro-dependent. Some of the more recently developed seeds may produce higher yields even without manufactured inputs, but the best results require the right amounts of chemical fertilizer, pesticides, and water. So as the new seeds spread, petrochemicals become part of farming. In India, adoption of the new seeds has been accompanied by a sixfold rise in fertilizer use per acre. Yet the quantity of agricultural production per ton of fertilizer used in India dropped by two-thirds during the Green Revolution years. In fact, over the past thirty years the annual growth of fertilizer use on Asian rice has been from three to forty times faster than the growth of rice yields.

Because farming methods that depend heavily on chemical fertilizers do not maintain the soil's natural fertility and because pesticides generate resistant pests, farmers need ever more fertilizers and pesticides just to achieve the same results. At the same time, those who profit from the increased use of fertilizers and pesticides fear labor organizing and use their new wealth to buy tractors and other machines, even though they are not required by the new seeds. This incremental shift leads to the industrialization of farming.

Once on the path of industrial agriculture, farming costs more. It can be more profitable, of course, but only if the prices

farmers get for their crops stay ahead of the costs of petrochemicals and machinery. Green Revolution proponents claim increases in net incomes from farms of all sizes once farmers adopt the more responsive seeds. But recent studies also show another trend: outlays for fertilizers and pesticides may be going up faster than yields, suggesting that Green Revolution farmers are now facing what U.S. farmers have experienced for decades-a cost-price squeeze.

In Central Luzon, Philippines, rice yield increased 13 percent during the 1980s, but came at the cost of a 21 percent increase in fertilizer use. In the Central Plains, yields went up only 6.5 percent, while fertilizer use rose 24 percent and pesticides jumped by 53 percent. In West Java, a 23 percent yield increase was virtually canceled by 65 and 69 percent increases in fertilizers and pesticides respectively.

To anyone following farm news here at home, these reports have a painfully familiar ring-and why wouldn't they? After all, the United States-not Mexico-is the true birthplace of the Green Revolution. Improved seeds combined with chemical fertilizers and pesticides have pushed corn yields up nearly three-fold since 1950, with smaller but still significant gains for wheat, rice, and soybeans. Since World War II, as larger harvests have pushed down the prices farmers get for their crops while the costs of farming have shot up, farmers' profit margins have been drastically narrowed. By the early 1990s, production costs had risen from about half to over 80 percent of gross farm income. So who survives today? Two very different groups: those few farmers who chose not to buy into industrialized agriculture and those able to keep expanding their acreage to make up for their lower per acre profit. Among this second select group are the top 1.2 percent of farms by income, those with $500,000 or more in yearly sales, dubbed "superfarms" by the U.S. Department of Agriculture. In 1969, the superfarms earned 16 percent of net farm income; by the late 1980s, they garnered nearly 40 percent.

Superfarms triumph not because they are more efficient food producers or because the Green Revolution technology itself favored them, but because of advantages that accrue to wealth and size. They have the capital to invest and the volume necessary to stay afloat even if profits per unit shrink. They have the political clout to shape tax policies in their favor. Over time, why should we expect the result of the cost-price squeeze to be any different in the Third World? In the United States, we've seen the number of farms drop by two-thirds and

average farm size more than double since World War II. The gutting of rural communities, the creation of inner-city slums, and the exacerbation of unemployment all followed in the wake of this vast migration from the land. Think what the equivalent rural exodus means in the Third World, where the number of jobless people is already double or triple our own.

Not Ecologically Sustainable

There is also growing evidence that Green Revolution-style farming is not ecologically sustainable, even for large farmers. In the 1990s, Green Revolution researchers themselves sounded the alarm about a disturbing trend that had only just come to light. After achieving dramatic increases in the early stages of the technological transformation, yields began falling in a number of Green Revolution areas. In Central Luzon, Philippines, rice yields grew steadily during the 1970s, peaked in the early 1980s, and have been dropping gradually ever since. Long-term experiments conducted by the International Rice Research Institute (IRRI) in both Central Luzon and Laguna Province confirm these results. Similar patterns have now been observed for rice-wheat systems in India and Nepal. The causes of this phenomenon have to do with forms of long-term soil degradation that are still poorly understood by scientists. An Indian farmer told Business Week his story:

> Dyal Singh knows that the soil on his 3.3-hectare [8 acre] farm in Punjab is becoming less fertile. So far, it hasn't hurt his harvest of wheat and corn. "There will be a great problem after 5 or 10 years," says the 63-year-old Sikh farmer. Years of using high-yield seeds that require heavy irrigation and chemical fertilizers have taken their toll on much of India's farmland.Š So far, 6 percent of agricultural land has been rendered useless.

Where yields are not actually declining, the rate of growth is slowing rapidly or leveling off, as has now been documented in China, North Korea, Indonesia, Myanmar, the Philippines, Thailand, Pakistan, and Sri Lanka.

The Green Revolution: Some Lessons

Having seen food production advance while hunger widens, we are now prepared to ask: under what conditions are greater harvests doomed to failure in eliminating hunger?

First, where farmland is bought and sold like any other commodity and society allows the unlimited accumulation of farmland by a few, superfarms replace family farms and all of society suffers.

Second, where the main producers of food-small farmers and farm workers-lack bargaining power relative to suppliers of farm inputs and food marketers, producers get a shrinking share of the rewards from farming.

Third, where dominant technology destroys the very basis for future production, by degrading the soil and generating pest and weed problems, it becomes increasingly difficult and costly to sustain yields.

Under these three conditions, mountains of additional food could not eliminate hunger, as hunger in America should never let us forget. The alternative is to create a viable and productive small farm agriculture using the principles of agroecology. That is the only model with the potential to end rural poverty, feed everyone, and protect the environment and the productivity of the land for future generations.

Successful Examples

That sounds good, but has it ever worked? From the United States to India, alternative agriculture is proving itself viable. In the United States, a landmark study by the prestigious National Research Council found that "alternative farmers often produce high per acre yields with significant reductions in costs per unit of crop harvested," despite the fact that "many federal policies discourage adoption of alternative practices." The Council concluded that "Federal commodity programs must be restructured to help farmers realize the full benefits of the productivity gains possible through alternative practices."

In South India, a 1993 study was carried out to compare "ecological farms" with matched "conventional" or chemical-intensive farms. The study's author found that the ecological farms were just as productive and profitable as the

chemical ones. He concluded that if extrapolated nationally, ecological farming would have "no negative impact on food security," and would reduce soil erosion and the depletion of soil fertility while greatly lessening dependence on external inputs.

But Cuba is where alternative agriculture has been put to its greatest test. Changes underway in that island nation since the collapse of trade with the former socialist bloc provide evidence that the alternative approach can work on a large scale. Before 1989, Cuba was a model Green Revolution-style farm economy, based on enormous production units, using vast quantities of imported chemicals and machinery to produce export crops, while over half of the island's food was imported. Although the government's commitment to equity, as well as favorable terms of trade offered by Eastern Europe, meant that Cubans were not undernourished, the underlying vulnerability of this style of farming was exposed when the collapse of the socialist bloc joined the already existing and soon to be tightened U.S. trade embargo.

Cuba was plunged into the worst food crisis in its history, with consumption of calories and protein dropping by perhaps as much as 30 percent. Nevertheless, by 1997, Cubans were eating almost as well as they did before 1989, yet comparatively little food and agrochemicals were being imported. What happened?

Faced with the impossibility of importing either food or agrochemical inputs, Cuba turned inward to create a more self-reliant agriculture based on higher crop prices to farmers, agroecological technology, smaller production units, and urban agriculture. The combination of a trade embargo, food shortages, and the opening of farmers' markets meant that farmers began to receive much better prices for their products. Given this incentive to produce, they did so, even in the absence of Green Revolution-style inputs. They were given a huge boost by the reorientation of government education, research, and extension toward alternative methods, as well as the rediscovery of traditional farming techniques.

As small farmers and cooperatives responded by increasing production while large-scale state farms stagnated and faced plunging yields, the government initiated the newest phase of revolutionary land reform, parceling out the state farms to their former employees as smaller-scale production units. Finally, the government mobilized support for a growing urban

agriculture movement-small-scale organic farming on vacant lots-which, together with the other changes, transformed Cuban cities and urban diets in just a few years.

The Cuban experience tells us that we can feed a nation's people with a small-farm model based on agroecological technology, and in so doing we can become more self-reliant in food production. A key lesson is that when farmers receive fairer prices, they produce, with or without Green Revolution seed and chemical inputs. If these expensive and noxious inputs are unnecessary, then we can dispense with them.

The Bottom Line

In the final analysis, if the history of the Green Revolution has taught us one thing, it is that increased food production can-and often does-go hand in hand with greater hunger. If the very basis of staying competitive in farming is buying expensive inputs, then wealthier farmers will inexorably win out over the poor, who are unlikely to find adequate employment to compensate for the loss of farming livelihoods. Hunger is not caused by a shortage of food, and cannot be eliminated by producing more.

This is why we must be skeptical when Monsanto, DuPont, Novartis, and other chemical-cum-biotechnology companies tell us that genetic engineering will boost crop yields and feed the hungry. The technologies they push have dubious benefits and well-documented risks, and the second Green Revolution they promise is no more likely to end hunger than the first.

Far too many people do not have access to the food that is already available because of deep and growing inequality. If agriculture can play any role in alleviating hunger, it will only be to the extent that the bias toward wealthier and larger farmers is reversed through pro-poor alternatives like land reform and sustainable agriculture, which reduce inequality and make small farmers the center of an economically vibrant rural economy.

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Collins, and Peter Rosset, with Luis Esparza (Grove Press/Earthscan, 1998).

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What are the basic kinds of solar cookers?

There are three basic kinds:

- Box cookers
  This type of cooker has been the advantage of slow, even cooking of large quantities of food. Variations include slanting the face toward the sun and the number of reflectors. You'll find an article discussing solar box cooker designs here.
- Panel cookers
  This recent development was sparked by Roger Bernard in France. In this design, various flat panels concentrate the sun's rays onto a pot inside a plastic bag or under a glass bowl. The advantage of this design is that they can be built in an hour or so for next to nothing. In Kenya, these are being manufactured for the Kakuma Refugee Camp project for US$2 each.
- Parabolic cookers
  These are usually concave disks that focus the light onto the bottom of a pot. The advantage is that foods cook about as fast as on a conventional stove. The disadvantage is that they are complicated to make, they must be focused often to follow the sun, and they can cause burns and eye injury if not used correctly. Some of these concerns have recently been reduced by Dr. Dieter Seifert's design.

There is a detailed document here showing a large number of variations on these themes. You can also listen to a good introduction to solar cooking here.

Who made the first solar cooker?

The first solar cooker we know of was invented by Horace de Saussure, a Swiss naturalist experimenting as early as 1767. See this article for more info.

Where are solar ovens being used the most?

There are reliable reports that there are over 100,000 cookers in use in both India and China. We are aware of solar cooking projects in most of the countries of the world. Solar Cookers International has recently had a breakthrough in Kenya using the Bernard solar panel cooker. More than 5000 families are now solar cooking there.

How hot do solar ovens get?

Place an oven thermometer in the sunny part of then oven to get a reading similar to what the cooking pot if "feeling". The temperature reached by box cookers and panel cookers depends

primarily on the number and size of the reflectors used. A single-reflector box cooker usually tops out at around 150° C (300° F) as the food approaches being done. High temperatures, however, are not needed for cooking. Your oven will cook just fine as long as it gets up to about 90° C (200° F) or so. Higher temperatures cook larger quantities, cook faster, and allow for cooking on marginal days; However, many people prefer to cook at lower temperatures, since then they can leave the food to cook while they go about their business. With a single-reflector box cooker, once the food is cooked, it just stays warm and doesn't scorch. It's good to keep in mind that no food can go above 100° C (212° F) anyway, until all of its water content has evaporated. The high temperatures you see in cookbooks for conventional ovens are just for convenience and for special effects such as quick browning.

How long does it take to cook a meal?

As a rule of thumb, you can figure that food in a single-reflector box cooker will take about twice as long as in a conventional oven . However, since you can't really burn your food, you don't have to watch the cooker or stir any food as it cooks. You can just put in a few pots with different foods and then come back later in the day and each pot will cook to perfection and then stay hot until you take it out.

Panel cookers cook smaller portions, usually only in a single pot, but often they cook slightly faster. Some people have reported the need to stir food every once in a while when using this kind of cooker to assure that the food heats evenly.

Cooking with a parabolic cooker is very similar to cooking on one burner of a conventional stove. Since the concentrated sunlight shines directly on the bottom of a pot, the pot heats up and cooks very quickly. The food will burn though. So you have to stir it and watch it carefully.

Do you have to turn the cooker to follow the sun?

Box cookers with one back reflector don't need to be turned unless you are cooking beans which take up to 5 hours. Panel cookers need to be turned more often than box cookers, since they have side reflectors that can shade the pot. Parabolic cookers are the most difficult to keep in focus. These need to be turned every 10 to 30 minutes, depending on the focal length.

Should I take the time to build a box cooker out of "real" materials like plywood or glass or is cardboard good enough?

Unless you need a cooker that can stay outside even in the rain, you'll do just fine with a cardboard cooker. Cardboard is much easier to work with and holds heat just as well. Some people we know have used the same cardboard box cooker for over 10 years.

Would a mirror make a better reflector?

While mirrors are more reflective than simpler materials such as aluminum foil, but the added gain is probably not worth the increased cost and fragility involved with using a mirror.

Does it help to paint the walls black?

Some people prefer to paint the walls black thinking that the oven will get hotter. It seems, however, that the walls will get hotter, but the food won't necessarily get hotter. We prefer to cover

the inner walls with aluminum foil to keep the light bouncing until it hits either the dark pot or the dark bottom tray. Since the bottom tray is in contact with the pot, the heat the tray collects will move into the pot easily.

What type of paint should I use?

In developed countries you can buy flat-black spray paint that says "non-toxic when dry" on the label. Otherwise, black tempera paint works, but you have to be careful not to wash it off when you wash the pot. Solar cookers in Uganda report that they use aluminum pots that have been blackened on the outside by fire.

Is glass better than plastic for the window?

People generally report that glass provides about 10% better performance than plastic. And there is reason to believe that under windy conditions, glass is preferred since it doesn't flap in the wind and dissipate heat from the cooker. Plastic, however, is often recommended since is much less fragile and easier to transport and works plenty well. One excellent, easily-obtained plastic film is oven cooking bags. These are for sale in grocery stores and cost less than US$1 per bag. Other plastics will also work. Plexiglas also works well.

What kind of pots work best?

Ideally, you want to use a dark, light-weight, shallow pot that is slightly larger than the food you will cook in it. Metal pans seem to cook best. Hardware stores in the US usually carry dark, speckled, metal pans called Graniteware. Shiny aluminum pots--so common in developing countries--can be painted black or can be blackened in a fire. Cast iron pots will work, but extra solar energy is used to heat up the pot as well as the food, so they will not work in marginal conditions.

What is the best insulation to use?

If you wish, you can insulate the walls of a box cooker with various substances. Fiberglass or Styrofoam is usually not recommended since they give off ill-smelling gases as they heat up. Natural substances such as cotton, wool, feathers, or even crumpled newspapers work well. Many people, however, leave the walls empty of any stuffing, preferring instead to place a piece of foiled cardboard as a baffle inside the wall airspace. This makes a lighter cooker and seems to be adequate. Most of the heat loss in a box cooker is through the glass or plastic, not through the walls. This is why a few percentage points of efficiency here or there in the walls doesn't effect on overall temperature and cooking power that much.

Could I use high-tech materials to make a more efficient solar cooker?

You may find that creating a high-performance cooker using fancy materials will make solar cooking more attractive to people in developed countries. In these countries, cooking only makes up a small percentage of daily energy use, but this is because people in developed countries consume enormous amounts of energy for other purposes (driving, lighting, air conditioning, etc.). Introducing these people to solar cooking is a good way to show them that they can integrate alternative energy into their lives. Solar cooking and drying clothes outside on a line are the simplest, least expensive ways to use solar energy to offset some of this high energy consumption.

This will hopefully open them to the possibility of using alternative energy in other ways.

Millions of poor people around the world, however, still cook over a smoky fire everyday. To find wood for the fire, they have to walk many hours everyday. Other poor city dwellers don't have access to wood, so they have to spend up to half of their income on cooking fuel. These people could never afford an oven made of high-tech materials.

So it's up to you to decide which population you want to serve. You could work on creating the most practical solar cooker for people in developed countries to help lead them into a greener future, or you can investigate how to make cookers out of cheap, locally-available materials for people in poor countries who can't afford more.

Can you sterilize water in a solar oven?

Yes. In all three types, water can be brought to a boil. A little-known fact, however, is that to make water safe to drink, it only has to be pasteurized, not sterilized. Pasteurization takes place at 65° C (150° F) in only 20 minutes. This treatment kills all human disease pathogens, but doesn't waste the energy needed to bring the water to a boil. One reason that people are told to boil their water is that thermometers are not readily available in many places and the boiling action serves as the temperature indicator. Dr. Robert Metcalf has written a very informative piece called Recent Advances in Solar Water Pasteurization. You will find other references in the Documents page of the Solar Cooking Archive.

Can you use a solar box cooker for canning?

Yes, but for fruits only! Do not can vegetables or meat in a solar box cooker, since these foods need to be canned under pressure! You'll find information on canning here.

Can you cook pasta in a solar box cooker?

To keep the pasta from getting pasty, use two pans. Heat the dry pasta with oil in one pan; heat the liquid with herbs in another. Fifteen to 20 minutes before eating, combine the two. If you are going to use a sauce, heat that in a third container.

If solar ovens are so good, why isn't everyone using one?

There are many factors at work here. First and foremost, the vast majority of the world's population does not even know that it is possible to cook with the sun. When they find out about it there is almost universal enthusiasm, especially in regions where the gathering of cooking fuel and the process of cooking over a smoky fire is a great burden. There are many factors that need to be in place to make it possible for poor people to solar cook on an on-going basis. The most successful projects have been ones where the need was the greatest, the weather the most favorable, and where the solar cooking promoters have taken a long-range approach to the transition. An example of this is the work by Solar Cookers International in the Kakuma refugee camp in Kenya.

If you build a box cooker out of cardboard, won't it catch fire?

No. Paper burns at 451° F and your cooker won't get that hot.

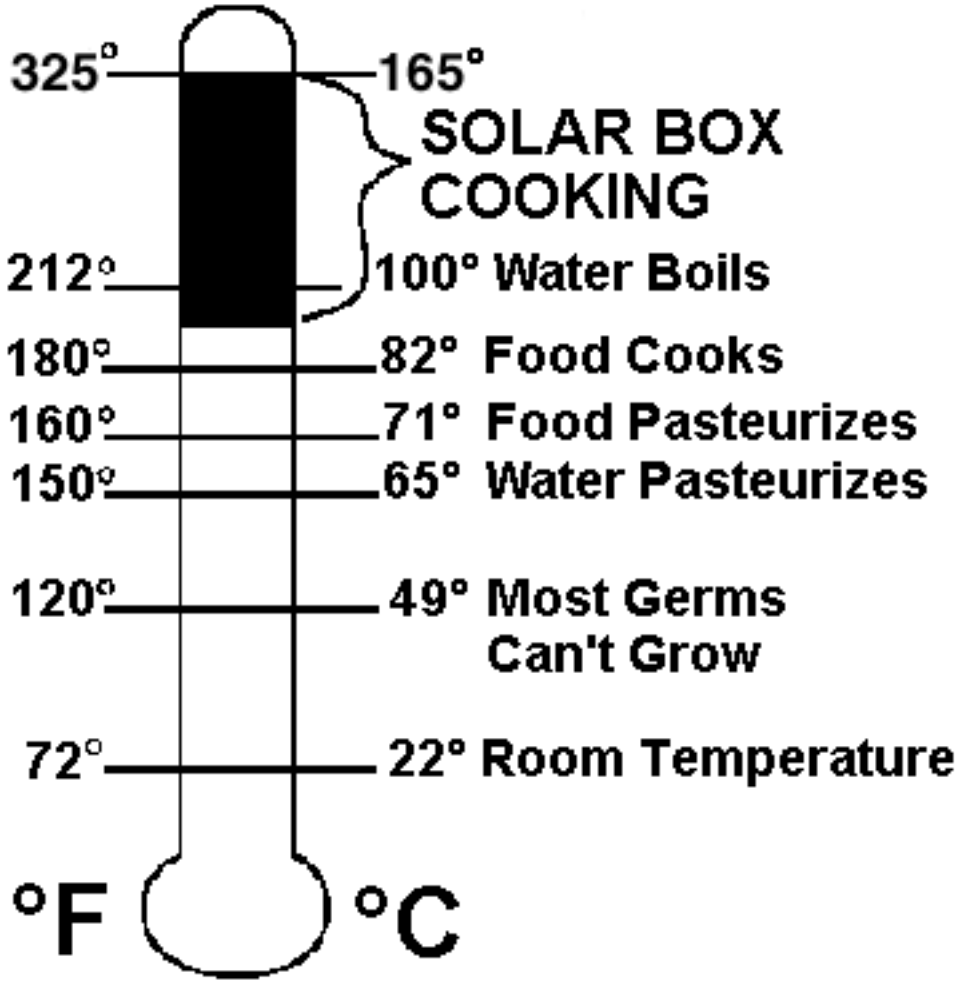
How much of the year can you cook?

In tropical regions and in the southern US you can cook all year depending on the weather. In areas as far north as Canada you can cook whenever it is clear except during the three coldest months of the year. Click the picture to see a map showing the amount of sunlight each part of the world receives.

What foods should I try first in my new Cooker?

A good first food to try is a small quantity of rice, since it is fairly easy to cook and looks very different cooked than it does raw. Chicken or fish is also very easy to cook. See cooking hints or cooking times.

My cooker only gets up to 250° F. Is this hot enough to cook when recipes call for 350°F or even 450° F?



A temperature of 250° F is plenty for all kinds of cooking. Remember that water cannot get hotter than 212° F (100° C). Thus if you are cooking food that contains water, it cannot get hotter than this either. Conventional cookbooks call for high temperatures to shorten the cooking time and for browning. Food just takes longer in most solar cookers, but since the sun is shining directly on the lid of the pot, the food browns just about as well as in a conventional oven.

What happens if the sun goes in front of the clouds while I'm cooking?

Your food will continue to cook as long as you have 20 minutes of sun an hour (using a box cooker). It is not recommended that you cook meats unattended when there is a possibility of substantial cloudiness. More information on food safety, go here. If you can be sure that the sky will stay clear though, you can put in any type of food in the morning, face the oven to the south, and the food will be cooked when you get home at the end of the day.

I'm planning to do a science project on solar cooking. What should I study?

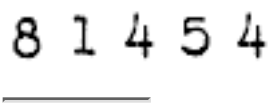
If you're planning a science project, Solar Cooker International wants you to know that your

research can help extend the world's knowledge of solar cooking and be of great help to people around the world. You should be aware that it's easy to build a high-performance solar cooker if you have access to modern materials. However, the more than a billion poor people in the world, who could really benefit from having a solar cooker, don't have access to such materials. This means that your research will be most useful if it concentrates on the simplification of cooker design or on the use of low-tech, local materials. For more information, see Topics Needing Research.

What resources are available online?

Solar Cookers International sponsors the Solar Cooking Archive on the World Wide Web at http://solarcooking.org where you will find illustrated construction plans, photographs, documents, and an international directory of solar cooking promoters. Their thrice-yearly newsletter, the Solar Cooker Review, is also available there. An excellent document for further reading is The Expanding World of Solar Box Cooking, by Barbara Kerr. You'll find a number of audio programs that you can listen to online here. Don't forget to read about eye safety here.

You can also subscribe to the Solarcooking-L mailing list by following the directions here. If you want to view an archive of past messages to this group, visit its message archive (also older messages archived here).



If you have comments or additions for this FAQ, please write to Tom Sponheim at webmaster@solarcooking.org.

The Solar Cooking Archive

Solar Cooking Documents

(Items marked NEW! were added in the last 30 days)

Documentos en Español Aquí

Frequently Asked Questions

- Frequently-Asked Questions (FAQ) (English)
- FAQ de la Cocción Solar (Spanish)
- FAQ sobre cozimento solar (Portuguese)
- Questions courantes sur les fours solaires (French)
- Solar Cooking FAQ (Japanese)
- FAQ de Cuina Solar (Catalan)
- 太阳灶常见问题解答(Chinese)
- Häufig gestellte Fragen (FAQ) (German)
- Domande frequenti sulla cucina solare (Italian)
- שאלות נפוצות FAQ - (Hebrew)

Newsletters

- **Solar Cooker Review -- July 2004** NEW! or Emailable version NEW!
- **Solar Cooker Review -- November 2003** or Emailable version
- **Solar Cooker Review -- July 2003** or Emailable version
- **Solar Cooker Review -- March 2003** or Emailable version
- **Solar Cooker Review -- November 2002** or Emailable version
- **Solar Cooker Review -- July 2002** or Emailable version
- **Solar Cooker Review -- March 2002** or

General Information

- Balancing the Scales -- Reducing Inequities with Solar Box Cookers (also in Chinese, French, Italian, Portuguese NEW!, and Spanish)
- The complete text of the book *The Expanding World of Solar Box Cooking*
- Food Safety and Solar Cooking (also in Italian and Portuguese NEW!, and Spanish)
- A History of Solar Cooking (also in Portuguese NEW!)
- Developing an Intuitive Feel for the Dynamics of Solar Cooking (also in Spanish)
- Review of Solar Cooker Designs
- Estimate Your Cost Savings from Solar Cooking (also in Portuguese NEW!)
- The Untapped Market for Solar Cookers (also in Portuguese NEW!)
- Map of average daily solar radiation in the U.S.
- Solar cooking recipes
- Fuelwood as Percentage of Energy Consumption in Developing Countries
- The Big Adventure of a Little Solar Cooker (also in French)
- Horace de Saussure and his Hot Boxes

Emailable version

- **Solar Cooker Review -- Nov. 2001** or Emailable version
- **Solar Cooker Review -- April 2001** - Spanish - Chinese
- **Solar Cooker Review -- December 2000**
- **Solar Cooker Review -- August 2000**
- **Solar Cooker Review -- April 2000**
- **Solar Cooker Review -- December 1999**
- **Solar Cooker Review -- August 1999**
- **Solar Cooker Review -- March 1999**
- **Solar Cooker Review -- December 1998**
- **Solar Cooker Review -- September 1997**
- **Solar Box Journal #18 -- October 1994**
- **Solar Box Journal #17 -- June 1994**
- **Solar Box Journal #16 -- February 1994**

Technical Information

- Principles of Solar Box Cooker Design (also in Chinese, Italian, and Portuguese)
- Arabic version of *Principles of Solar Box Cooker Design*
- Review of Solar Cooker Designs
- Through-the-Wall Ovens
- The Barbara Kerr Solar Wall Oven Do-It-Yourself Guidelines
- Cooking *Ugali* in a Solar Box Cooker
- The Physics of Solar Cooking
- Tips on Construction and Cooking (also in Italian)

of the 1700's

- Cooking smoke: a pervasive killer in developing countries
- The Villager Sun Oven
- Solar Cooking on the Roof
- Report from the 1992 World Conference on Solar Cooking in Stockton, California
- Mipango ya jiko la jua
- Do High Efficiency Woodstoves Create More Greenhouse Gasses?
- The Sustainable Kitchen
- Solar Cookers a Hit at Rio Conference
- Making Solar Box Cookers
- The Importance of Eye Safety in Solar Cooking
- Solar Box Cookers for Schools
- Recipe for Solar Seed Bars
- The Energy Crisis on a Global Scale -- Solar Cookers offer a practical solution
- Interview with S. Narayanaswami on solar cooking in India
- The 'Solar Crêperie' - Promotion of Solar Cooking by Selling Pancakes
- Solar Bakeries: Creating Self-sustaining, Self-Propagating Micro-Enterprise
- Requirements for a successful solar cooker programme
- UN Report: Domestic Fuel Shortage and Indoor Air Pollution
- UN Report: Indoor Air Pollution in Developing Countries (pdf)
- An Anthology on Women, Health and Environment: Domestic Fuel Shortage

- Tips and Tricks 1, 2, 3
- A Story Illustrating the Application of Solar Cooker Design Principles in a Field Project
- Canning Fruits with a Solar Box Cooker
- Rating Solar Cookers
- Testing and Reporting Solar Cooker Performance NEW!
- Recipes for Wheat Paste (also in Italian)
- Pot with Integrated Greenhouse for Solar Panel Cooker
- Comparison of Lids for Greenhouse Pots for Solar Panel Cookers
- Technical Description of the Largest Solar Steam Cooker in the world
- The WHO Golden Rules for Safe Food Preparation
- US Solar Radiation Maps
- Solar Oven Trackers
- Information on the solar absorbtivity and emmitance of various materials
- Designing and Building Home Made Focusing Solar Cookers
- Bob Culbertson's Heat Booster
- International Standards for Testing Solar Cookers
- Solar Tracking With A Box-Style Cooker
- Tests of the Solar Funnel and Bowl Cookers in 2001
- Converting a Box Cooker to Have Round Inner Walls
- A Parabolic Cooker for Unattended Cooking
- The Kerr-Cole Large Solar Panel/Propane Hybrid Stoves
- A Simple Solar (Sunflower) Autoclave Design
- and Indoor Air Pollution
- Ecological Cookers: An essential Element in Bettering Household Health

Country Reports

- Afghanistan: Continuing War in Afghanistan Intensifies Demand for Solar Cookers. An interview with Steven Brown of SERVE.
- Bolivia: New report shows high-levels of solar cooker use in Bolivia.
- Burkina Faso: The Fuel Wood Crisis in Burkina Faso - Solar Cookers as an Alternative (also in French here)
- Burkina Faso: Report on Solar Cooking Activities in Mali and Burkina Faso
- Egypt: Solar and other Energies in EGYPT (featuring giant Scheffler cookers)
- Egypt: Egyptian University Graduates Discover Solar Cooking Benefits
- Ethiopia: A Solar Cooker Project in Ethiopia
- Gambia: Spreading Solar Cooking in Gambia
- Haiti: Another Busy Year for Free Methodists in Haiti
- Haiti: Solar Cooking Promotion Grows in Haiti
- Haiti: HAITI 2001 -- Reflecting The Light
- Honduras: Bakery Co-Operative in San Antonio, Honduras -- One Year Later
- India: Solar Cooking Technology -

- Testing and Reporting Solar Cooker Performance
- Solar Dryer Systems and the Internet: important resources to improve food preparation
- Using a Solar Oven as a Radiant Refrigerator at Night
- Making a Parabolic Reflector Out of a Flat Sheet
- An Alignment Template for Unattended Solar Cooking
- Robustness of a Reflective Solar Cooker
- Side-By-Side Comparison of the Various Panel Cookers
- Investigation of Reflective Materials for the Solar Cooker
- Program for calculating the shape of parabolas for concentrating solar cookers
- Tests using a photovoltaic cell to compare reflectors and various glazing materials (pdf)
- Power From The Sun
- Development of a Comparative Framework for Evaluating the Performance of Solar Cooking Devices (Word Doc)

Water Pasteurization and Disinfection

- A Summary of Water Pasteurization Techniques (also in Italian)
- Water safety clearly explained in audio interview with Dr. Robert Metcalf (or read the transcript)
- The Science of Safe Water
- The Solar Puddle Water Pasteurizer
- Recent Advances in Solar Water Pasteurization (also in Italian)
- Sun and water: an overview of solar water

How Far are Technology Promoters and Users From Each Other?

- India: The Experience of ULOG with Small Scale Projects Promoting Solar Box Cookers and Scheffler Reflectors
- Guatemala: Sol*Saver on the Job in Tanzania and Guatemala
- Kenya: Kakuma Refugee Solar Cooking Project
- Kenya: Cookstoves for the Developing World (Kenya)
- Kenya: Introducing Solar Ovens to Rural Kenya
- Kenya: Interview with Kenyan refugee trainers, Jay Campbell and Barbara Knudson (10/95)
- Kenya: Interview with Dr. Robert Metcalf on his return from trainings in Dadaab, Kenya (10/95)
- Kenya: Solar Cooking in Kenya
- Kenya: The Trans World Radio Solar Cooker Project in Kenya
- Kenya: The Kenyan Solar Oven Market (.pdf)
- Ladakh: Solar Cooking in Ladakh
- Lesotho: Diffusion of innovation: Solar Oven Use in Lesotho
- Madagascar: Solar Relief for Madagascar Cooks
- Mali: Mali Solar Cooking Project -- One Year Later
- Mali: A Solar Pioneer in Mali
- Mali: Report on Solar Cooking Activities in Mali and Burkina Faso
- Mexico: Solar cooking catches fire in Mexican nature reserve

treatment devices
- Solar Disinfection Studies
- Solar Water Disinfection
- To Drink Without Risk: The Use of Ultraviolet Light to Disinfect Drinking Water in Developing Countries
- New Water Pasteurization Technology Saves Lives in Developing Countries
- Solar Thermal Water Pasteurizer Provides Safe Drinking Water
- Solar water disinfection through plastic bottles
- Water Disinfection Using Solar Radiation
- Moringa Seeds Used in Water Purification
- Solar Kettle Thermos Flask now in commercial production

Retained Heat Cooking

- Retained Heat Cooking
- Efficient Haybox Construction
- Information on Hayboxes
- Heat Retention Cooking vs. Solar Cooking
- Interview with Mike Bridgwater about his work in combining solar cooker and heat-retention cooking in Tanzania.
- Tanzania 2001 Report
- Building a Hay Sack Cooker

Solar Food Drying

- Solar Drying - presented at the International Conference on Solar Cooking in Kimberly, South Africa
- A Review of Solar Food Drying
- Solar Dryers

- Mozambique: Report from the Grupo Faísca in Mozambique
- Namibia: Thesis: Solar Cookers for Use in Namibia
- Nepal: Developing a Co-Operation Project in Nepal
- Nepal: TFL Solar cooker project in Nepal
- Nepal: Solar Cookers as a Means for Reducing Deforestation in Nepal
- Nepal: Report on Solar Cooker and Solar Dryer Demonstration at Basantapur, Kathmandu Nepal
- Nepal: Solar Cookers in Nepal
- Nicaragua: Centro Girasoles Proceso (also in English here).
- Peru: Case Study of Solar Stoves Made and Used in the Peruvian Andes
- Sri Lanka: Villagers in Sri Lanka Learn to Solar Cook
- South Africa: Solar Cookers and Social Classes in Southern Africa
- South Africa: Social Acceptance of Solar Stoves in South Africa
- South Africa: Solar Cooking in South Africa, Final Report.
- South Africa: Ensayo de cocinas solares en Sudafrica
- Tanzania: Sol*Saver on the Job in Tanzania and Guatemala
- Tanzania: Solar Water Pasteurization in Tanzania
- Turkey: Turkey Project off to a Good Start
- Turkey: An interview with Barbara Knudson

Solar Refrigeration

- EG Solar: Refrigerating with the Sun
- A Solar Ammonia Absorption Ice Maker

- Turkey: Report on Solar Cooking in in Turkey (December 2002)
- Zimbabwe: Thesis: Solar Box Cookers in Zimbabwe: The Introduction of a Radical Innovation in Cooking, and Bibliography
- Various: Solar Cooking in Switzerland and the Use of Cookers in Africa and India
- Various: Solar Cooking Dissemination Strategies -- Experiences in Nepal, Mongolia and Peru

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For questions or comments, contact
webmaster@solarcooking.org

http://solarcooking.org/docs.htm

The Solar Cooking Archive

Search

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Joining the Solarcooking-L Email Discussion Group

Before you join the mailing list, make sure that you can't get the information you need by simply viewing the discussion archives. If, however, you would like to participate directly, then click on the link below and then click Send in your email program:

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solarcooking-l · Solar cooking and water pasteurization

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Join This Group! (Already receiving group email?)

Description

Category: Other

[Last updated on: Wed May 15 19:56:09 1996]
Welcome to the solar cooking email discussion group! This list is for those who want to share information on solar cooking and water pasteurization using solar cookers. The list is open to anyone from any country who wishes to join. Please feel free to send any ideas, questions, information, etc. on solar cooking that you have.

As a new subscriber you are encouraged to write a short introductory message telling the other members of the group your relation to solar cooking. If you would like to receive a compilation of other members' bios, send an email message to tomsp@microsoft.com with "get bios" as the subject. We also encourage you to tell other solar cooking enthusiasts you know about this group. All they need to participate is an email account.

The facilitator of the list is Tom Sponheim (tsponheim@accessone.com) the webmaster of The Solar Cooking Archive on the World Wide Web at http://www.accessone.com/~sbcn/index.htm.

Tom is also president of Solar Box Cookers Northwest (7036 18th Ave. NE, Seattle, WA 98115 USA), a non-profit, educational sister organization of Solar Cookers International (1724 11th St., Sacramento, Calif. 95814 USA -- Tel: (916) 444-6616 Fax: (916) 444-5379 Email: sbci@igc.apc.org)

If you would like to find out who is on this list, send an email message to majordomo@igc.apc.org with the following in the body of the message:

who solarcooking-l

If you want to get off this list, please send a message to majordomo@igc.apc.org with this in the body:

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What's New

Nothing new within the last 7 days

Recent Messages

View all Messages (3553)

Messages in this group are sent from a remote email list:**solarcooking-l@topica.com**

Group Info

Members: **168**
Founded: **Aug 6, 1998**

Group Settings

- Listed in directory
- Open membership
- Unmoderated
- All members may post
- Public archives
- Email attachments are permitted

RSS **Get messages in RSS** | Add to My Yahoo!

Jul 30	new archive and group location - **Carl Page**
Jan 18	Re: Why be so unfair to the solar cooker - **Bob Dahlquist**
Jan 18	Re: Rebates for alternate energy installations - **Bob Dahlquist**
Jan 18	Re: Simple Hole in the Ground Cooker - **Bob Dahlquist**
Jan 18	Re: Digest for solarcooking-l@i..., iss - **Bob Dahlquist**

Message History

Search Archive

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	139						1					
2000	175	107	231	50	132	122	62	98	65	65	22	150
1999	114	50	46	81	99	121	38	158	49	161	80	46
1998	25	19	175	76	75	48	39	38	76	14	63	103
1997	47	44	18	12	21	34	18	15	29	17	16	11
1996												46

Group Email Addresses

Post message: solarcooking-l@topica.com

Yahoo! Sponsored Links

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UAT - Computer Science Training: Looking for an accredited grad or undergrad school? UAT offers High-tech degree and certification programs on campus and online.
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Links to Other Solar Cooking Resources on the Web

(items marked NEW! were added in the last 30 days)

English

- Click here to see who links to the Solar Cooking Archive.
- KerrCole Sustainable Living Center
- Solar Household Energy, Inc.
- Cooking with the Sun Under a Rainbow
- A Solar Cooker Project in Ethiopia
- Baha'i Vocational Institute for Rural Women
- Lesson Plan: Solar Energy: Become a Sun Chef!
- Linkages: A multimedia resource for environment and development policy makers
- Large collection of solar energy patents, including concentrating solar cookers
- Nature-Friendly

French

- Centre Neuchatelois de cuisine solaire
- Four Solaire Développement

German

- EG-Solar
- Solarkocher-Adressen
- Solarkocher als Baumschoner
- Solarkocher für Ibungila
- Alternative Energie - BSW - Bio, Sonne, Wasser, Wind
- ULOG Sonnenkocher
- Karte: Deutschlands Durchschnittliche Sonnenstunden in Studen pro Jahr
- Solarkocher zur Ausleihe
- Alternative Energie -- Förderverein für die Entwicklungsländer e.V.
- Solar Ovens for Europe
- Kochen mit der Sonne in Kenia
- Solarbrücke
- Projektgruppe Solartechnik
- Jahresarbeit von Mathias Pappert - Solarofen - Sonnenenergie sinnvoll nutzen

Portuguese NEW!

- Development of a model of dismounted solar cooker to camping
- Solar cooker at human activity: utilizing renewable energy to cook food

Experimental Home (New Zealand)

- FAST-Solar -- Friendly Appropriate Solar Technologies
- The Kona Cooker
- Tamara's Solar Cooking Pages
- Solar-Dried Coffee Technology -- Buy the coffee here
- Solar cooking class project in Arizona
- Solar Oven and Radiation (SOAR)
- Centre for Rural Technology (Nepal)
- Solar Cooking Addresses
- ClearDome Solar Ovens
- Giant solar cooking system at Mt. Abu, India.
- Solar Cooking for Campers
- Site describing The KAB of the Diocese of Munich's solar cooking project in Chimbote, Peru
- Large new South African solar cooking site now online
- ULOG Website
- Paraíba and solar cookers - renewed pioneerism!
- Solar cookers
- Solar cooking at human activity
- Solar oven
- Institute incentives further use of solar energy in Brazil
- Solar cooker changes agriculturist's life (with video) • Engineers designed a solar cooker

Spanish

- Solar Cooking Archive en Español
- No hay nada nuevo bajo el sol
- Curso Taller: Cocinas y Hornos Solares -- Cusco, 25, 26 y 27 de Agosto 1999
- Ingeniería Sin Fronteras de Granada
- Red Iberoamericana de cocción solar de los alimentos
- Cocinas Solares: *Serie Divulgativa (España)*
- Concurso de "Cocinas Solares Y Technologías Appropriadas
- SolarWeb.Net
- SHAMS - Energía Solar y Vida

Other

- A large site on solar cooking in Japanese
- Yasuko Torii's solar cooking site (in Japanese)
- 太陽熱調理器の作り方とオンライン情報集
- Solar Box Cooker Plans in Malagasy
- The Vajra Foundation (Dutch)

Links Peripherally related to Solar Cooking

- Production Mini-Plants in Mobile Containers (.pdf)
- Solar Tunnel Dryer
- A solar lamp that can be manufactured in small villages
- A Solar Collector for Pasteurizing Composted Human Waste

- World Community Service Project.Invitation
- Jade Mountain Inc.Website
- Building parabolic solar cookers from local materials in Nepal
- Solar Concentrating System Website
- Solar Systems/John Balafoutis
- Smokeless Cooking Products
- The Physics of Solar Cooking
- Yasuko Torii's solar cooking site
- The Aprovecho Research Center
- Project Results: Wind and Sun Power for Kenya
- Kit 22: Solar Energy
- Solar Food Dryers
- El Sol Simpatico -- Working in El Salvador
- Things That Work -- The Sun Oven
- Home & Heart
- Cookin' with Sunshine
- Home Power's 2nd Annual Solar Cooker Contest

- Heaven's Flame Solar Cooker
- The 1992 World Conference on Solar Cooking
- Map of solar radiation in the USA.
- Solar Energy International website
- Center for Rural Technology, Nepal
- The Global Sun Oven
- Solar cooking at Stanford University
- Home Power Magazine
- The WOT homepage of the Solar-Energy Group
- Taylor Publishing: Small Building Projects
- AproTech Rocket Stoves
- SolarSoft: A solar cooking project in Lesotho
- Box-Aid
- The Bachat Cooker
- Journey to Forever
- Solar Household Energy, Inc.
- Lifewater International
- Palmer Development Consulting

- The Tulsi Solar Cooker website
- Tata Energy Research Institute (India)
- Solar Oven Society

Please send any link suggestions to the Webmaster.

The Solar Cooking Archive

(From: Silence No. 202 - March 1996) SOLAR ENERGY

The Big Adventure of a Little Solar Cooker

by Roger Bernard

(Translated from the French by Darwin O'Ryan Curtis)

Half the inhabitants of earth burn wood to cook but more than a billion and a half of these people are having difficulty finding the fuel. If nothing is done, this situation can only grow worse because there are ever more inhabitants of earth and fewer and fewer trees. In the year 2000, according to United Nations estimates, 2.4 billion people will suffer from a shortage of fuel wood.

Increasing deforestation causes numerous other degradations of the environment such as:

- climate modification,
- floods,
- erosion by wind and rain,
- the destruction of arable land.

Because the affected regions generally have high insolation, (sometimes more than 300 days of sun per year), it is reasonable to project the use of solar energy everywhere possible, while reserving wood - that solar energy "in the can" - for sunless hours and days.

Much research all around the world has resulted in the production of all kinds of solar cookers. (1) (2) (3)

While solutions could be found for most technical difficulties, socio-cultural problems, on the other hand, long remained insoluble. Even in countries in the process of desertification, notably in Africa, people continued, for better or for worse, to burn the little wood that remained rather than accepting flameless cookers they were not used to.

Recently, this situation is finally changing thanks to the almost simultaneous emergence of the three following factors:

- first, a particularly dynamic organization, Solar Cookers International, decided to focus on the problem;
- next came a particularly dramatic event, the surge of Rwandans into refugee camps and
- last, the appearance of a particularly simple device: a new solar cooker.

There follows an account of its development.

Born In Lyons, France

The Lyonnaise Association For The Study and Development of Solar Energy, (ALEDES), based at the University of Lyons I, has been interested in solar cooking for fifteen years. A number of

different cookers have been designed there and then tried out in various developing countries: Senegal, Burkina Faso, Mali, The Central African Republic, Vietnam, Haiti. In general, the cookers functioned well but they proved too sophisticated, thus too difficult to manufacture and too expensive, to lend themselves to mass production.

Paradoxically, it was in seeking the solution to another problem that we conceived of a cooker that would finally work well in Africa. An organization wishing to demonstrate solar energy to school children asked us to design a cooker simple enough for 10 year olds to build without tools in less than one hour.

We first considered a solar box cooker which is composed of nested boxes with summary insulation like crumpled up paper in between, and covered with a piece of glass to trap solar radiation. (4) (It is possible to improve the performance of this model by lining the interior with aluminum paper that will reflect additional solar rays onto the cooking utensil.) However, it seemed a bit risky for children to be handling glass panes that could be easily dropped, break and cut fingers. So, for safety reasons, we were led to discard the glass, which, in turn, rendered the insolation useless. Conversely, we increased the reflective surfaces to compensate for heat loss. The insulation was no longer provided by a fragile piece of glass but by a simple, transparent Pyrex salad bowl inverted over the cooking pot, as depicted in fig.1. This apparatus was made simply by cutting up a cardboard carton for bottles and pasting aluminum foil to the resulting panels.

Baptized In Taylor

At Taylor, in the mountains of Arizona, lives a pioneer of solar cooking: Barbara Kerr, who built and distributed the first solar box cookers in the United States back in the 1970s (5). As soon as she heard of our new prototype, she built one and tested it, solar cooking being possible in Arizona even in winter. It is she who baptized it the "panel cooker," which is to say a cooker of reflective panels. She also changed its form a bit, permitting sharper folds and greater stability. Because this model seemed best suited for campers due to its light weight and modest volume when folded up, Barbara Kerr replaced the relatively heavy and cumbersome salad bowl with an oven-proof transparent plastic bag, fig. 2.

The February, 1994 issue of the Solar Box Journal, published both a description of the original prototype (6) and of Barbara Kerr's modification (7). She also presented these models the following July during the International Congress on Solar Cooking at Heredia, Costa Rica (8).

Improved In Sacramento

Since 1987 Solar Cookers International (SCI) had existed in Sacramento with the mission of promoting the solar box cooker throughout the world. (See box.) After Barbara Kerr, several members of this organization built their own "panel cookers" and were agreeably surprised by the results achieved at so modest a cost. Each one suggested ways of further improving the stability and efficiency of the prototype. In particular, Beverly Blum, Edwin Pejack and Jay Campbell suggested modifications to adapt the cooker to the Torrid Zone. In fact, the three vertical reflective panels which functioned well in the Temperate Zone, (for example in France), lose their efficiency if the sun is very high in the sky because its rays glance off at too shallow an angle. It is therefore better to slant the panels backward, as is shown in fig. 3, where the central panel no longer has the

shape of a rectangle, but is, rather, trapezoidal.

The "CooKit" weighs only 500 grams and folds into a volume of 33x33x6 centimeters. In SCI's newsletter we read (9): "Compared to what we have always called our standard 'simple solar box ,' it is even1) simpler, 2) easier to make with fewer materials, (no window! just half one box), 3)more compact, and 4) easier to set up, take down and store in seconds. Furthermore, the model made by SCI is sold in the United States for75FF ($15) as opposed to 290FF ($58) for the solar box cooker. Thus the mass production of the CooKit and its distribution in the developing world became a possibility. Contributions were solicited from the members of SCI to cover expenses. 115,000FF ($23,000) were raised, and this sum was doubled by an anonymous donor. The Rotary Club added another 97,000FF ($19,500). Only the most difficult consideration remained to be confronted: the human equation.

Accepted In Kakuma

The first field contacts occurred in Nairobi in September 1994 between a couple of SCI volunteers from California and their Kenyan homologues. With the authorization of the UNHCR (10), they chose a place to experiment in a semi-arid zone of northwest Kenya. It is the refugee camp at Kakuma where some 30,000 refugees are surviving in precarious conditions. There is a fortnightly distribution of food and a few sticks of wood inadequate to cook it. Some refugees go as far as twelve kilometers (7 miles) from the camp to cut down trees for firewood, which provokes disputes with the locals. Others barter some of their meager food ration against some wood with which they can cook what's left.

In January, 1995, the camp was visited by Beverly Blum, SCI Executive Director, Barbara Knudson, Jay Campbell and their Kenyan colleague, Faustine Odaba, who served as interpreter. There was no dearth of difficulties with so many languages spoken in the camp, so many cultures and so many different cooking traditions.

At the outset, a small group of refugees was formed to try solar cooking all the basic foods available at the camp: rice, beans, bread, sorghum and ugali. This experiment having been a notable success, 12 women agreed to try solar cooking at home. After receiving two days of practical training, each was issued a cooker, a black pot, a plastic bag and three supplemental rations of food so as not put their own supplies at risk.

The SCI volunteers then organized home visits and meetings to deal with any problems that arose. After a couple of weeks, little girls were learning how to solar cook from their mothers, and one woman began selling solar cooked bread. A month and a half later, 69 families were using their solar cookers on a regular basis, and 16 women had received training as solar cooking instructors, to teach the new technique to other refugees.

After overcoming a few difficulties, and adjusting to a cooking time markedly longer than for wood fires, Africans began to discover and appreciate the advantages of solar cooking:

- no smoke inhalation
- minimal water requirement
- reduced surveillance
- no risk of burning the food

- no soot accumulation on pots.
- no worry about fire
- no burns from fire or coals, (notably of the children).

An observer from the United Nations High Commission For Refugees reported: "The planning and execution of the SCI training programme has been extremely impressive. Refugee participation is very high...The new solar cooking device seems to avoid most of the technical and acceptance problems associated with cumbersome box cookers."

In June, the stock of cookers from the United States having been depleted, cookers "made in Kenya," manufactured by Africans in Nairobi, were put to use. In September, 1995, only two years after the invention of this type of cooker, and thanks to the efficiency of SCI, more than 1000 families were using it; more than 5000 people had experienced the proof that the sun could help them.

According to Bev Blum, "the keys to success are a sunny climate and consumers who: 1) have a motive (such as cooking fuel shortage), 2) receive adequate instruction, and 3) have group encouragement to adapt solar cooking to their needs,
sometimes through group problem-solving." I would add that the very major participation of women, both from SCI and from the refugee community, seems to me to have been another important key to the success at Kakuma.

It remains to be hoped that everyone will now understand the importance of solar cooking; that it should not be considered solely as a life preserver in desperate situations, but also as a means of lightening domestic tasks and preserving the environment everywhere there is the menace of desertification. And that those in authority will act before, rather than after, the desertification occurs.

Roger Bernard
ALEDES

Contact: ALEDES, Université Lyon I, 69622 Villeurbanne, France

(A hearty thanks to SCI, and particularly to Beverly Blum, Barbara Kerr, Tom Sponheim and Kevin Coyle who cheerfully provided me with several documents for this article.)

* * *

FOOTNOTES

1 - Alward, Ron, Solar Cooker Manual , (Quebec: Brace Research Institute, 1982).

2 - Bernard, Roger, "Le Soleil à Votre Table," Ed. Silence, 1987.

3- Kuhnke, Klaus, Solar Cookers In The Third World, (Braunschweig: Vieweg, 1990).

4 - Solar Cookers International, How To Make, Use and Understand Solar Cookers.

5 - Kerr, Barbara, The Expanding World Of Solar Box Cookers, 1991.

6 - "The Bernard Solar Panel Cooker," Solar Box Journal No. 16, February, 1994.

7 - Barbara Kerr Tests The Solar Panel Cooker (ibid).

8 - Kerr, Barbara, Solar Panel Cookers, A New Low-Tech Design Line, (Proceedings of the Second World Conference On Solar Cookers, Heredia, Costa Rica, July1994)

9 - "New Solar Cooker," SCI Newsletter, Fall, 1994.

10 - United Nations High Commission For Refugees.

11 - Blum, Beverly, Dissemination of Solar Cooking In Areas Of Acute Fuel Shortages, (U. N. Environmental Programme Seminar on Gender and Environment, Nairobi, Kenya, April, 1995.

SIDEBARS AND CAPTIONS

Page 26

Sidebar:
For a long time, Africans shunned solar cooking as too different from their habitual wood fires. But things are beginning to change for the greater good of trees...and of people.

Page 27
first caption:
The First Prototype (Lyons, July 1993) (author's drawing) second caption: The Second Prototype (Taylor, November 1993) (drawing by Leona Christie, from Solar Box Journal, No. 16, February, 1994)

Page 28
caption:
The "CooKit," a "tropical" model with inclined panels (summer, 1994)

Sidebar
SOLAR COOKERS INTERNATIONAL
This non-profit organization is dedicated to promoting solar cooking worldwide as a service to people and to their environment. It sells cookers and training materials, including some in French and Spanish. It publishes a periodical, "The Solar Cooker Review." For additional information, contact the author of this article or write directly to SCI at: 1724 Eleventh Street, Sacramento, CA 95814, USA.

Page 29
caption:
A solar cooking demonstration at Kakuma by Faustine Odaba, (January 1995). The spectators are

soon to become actresses. (photo: SCI)

sidebar:
This article appeared in the monthly magazine "SILENCE," No. 202, March 1996. The publisher is: Editions Silence, 9 rue Dumenge, 69004, Lyons, France, which also publishes books in French on the ecology, non-violence and alternative life styles. A catalog is available on request.

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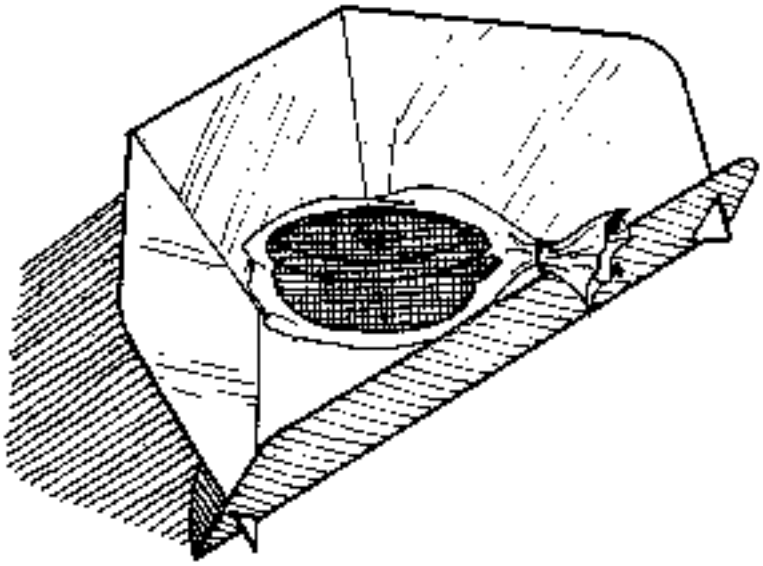
The "Cookit" Foldable Family Panel

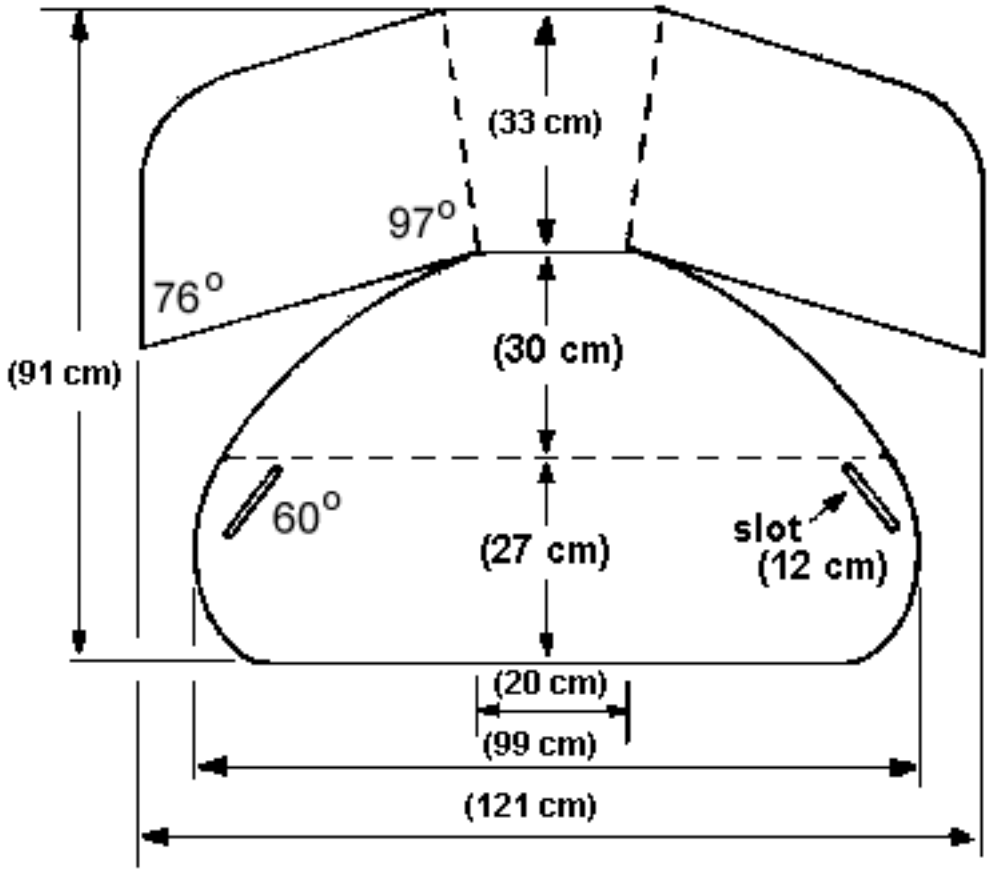


The Foldable Family Panel is neither a "solar oven" or "curved concentrator" but a happy hybrid. Its utter simplicity belies its powerful cooking power. Its low cost brings solar cooking to a much wider market of people.

It is handy for cooking food, baking breads, pasteurizing water, and teaching the basics of solar energy.

Co-developers are Roger Bernard of France and Barbara Kerr of the USA, with work also by Edwin Pejack, Jay Campbell, and Bev Blum of Solar Cookers International. Extensive field tests in the USA and with refugees in Kenya confirm its performance, convenience, low cost, acceptance, and adaptability to diverse needs.

Construction



Start with a big piece of cardboard about 1m x 1.33m (3'x 4'). Cut and fold as shown. The angles and folds shown are best, but small variations are OK.

Hints: To make clean straight folds in cardboard, first make a crease along the line with a blunt edge such as a spoon handle, then fold against a firm straight edge.

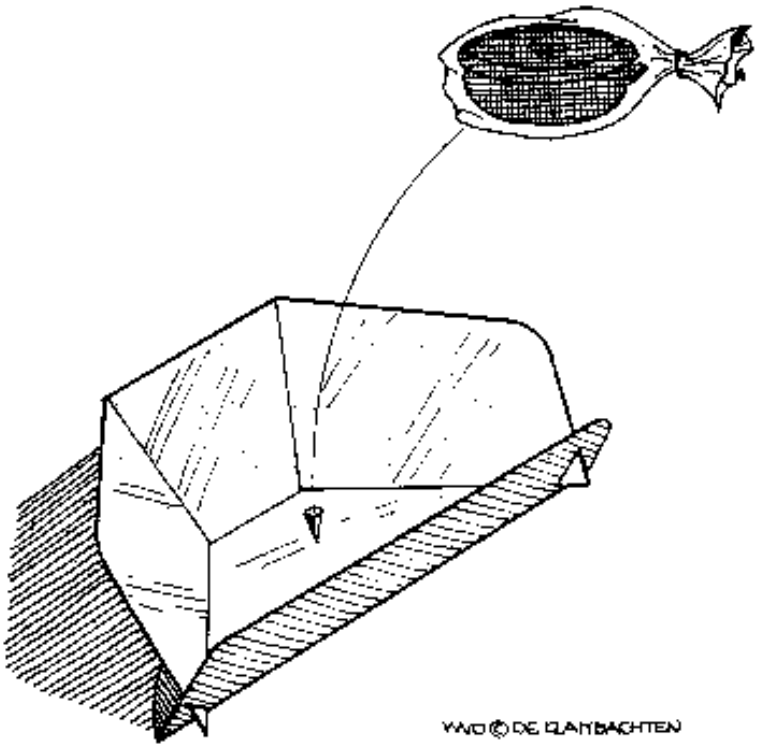
Make the slots a little too small and narrow so that they fit snugly to hold up the front panel.

Glue aluminum foil on the side that will form the inside surfaces when the oven is set up for cooking.

To set up, lay panel flat with shiny side up. Fold up front and back parts and fit back corners into the slots in front.

You're ready to cook! Put your food into a dark-colored pot. Then place the pot inside a plastic bag (an oven cooking bag will withstand the heat best). Close the open end of the bag and place pot and bag into the center of the cooker.

You can order a pre-built Cookit here.



Tips and Tricks

- Dr. Steven Jones found that raising the pot on a wire frame improved cooking in a panel cooker.

- Wietske Jongbloed created a simple frame to protect plastic bags from damage.

For questions or comments, contact
webmaster@solarcooking.org

http://solarcooking.org/cookit.htm

The Solar Cooking Archive

Kakuma Refugee Solar Cooking Project--Report #1

Kakuma, Kenya
January-February, 1995

Overall, the first phase of introducing solar cooking to refugees in the Kakuma camp has been a success. Our original plan required only modest adjustments, and as February ends we have met or exceeded all of our phase-one objectives, and the basis is set for phases two and three.

We taught solar cooking skills to 100 women and trained 16 of them to teach others. I fully expect that by mid-year we will serve more than the 500 families we had originally estimated.

Speaking personally, work on this project has been thrilling. Everything has gone much better than we had dared to hope. The excitment created in the camp by solar cooking, and the warm feelings shared with our Kenyan counterparts and the trainees, were deeply moving. Some very grateful women even kissed my hand--I was a little embarrassed. We send their thanks to all of you who helped put together this successful first phase.

Specific Objectives Reached

1. The new, ultra-simple "Cookit" panel cooker works amazingly well, as the refugees quickly proved for themselves.
2. In 6 short weeks, 100 refugee families have begun solar cooking. Women were trained in small group sessions involving 6 to 12 at a time. The women were enthusiastic participants, speedy learners, and happy with the whole business. Trainees included women from the Sudan, Rwanda, Somalia, Zaire, Uganda and from the Oromo and Amharic groups of Ethiopia.

   The women are using the cookers on virtually every sunny day to cook their basic rations of maize meal, wheat flour and beans. They also have adventurously branched out into a variety of new dishes, including vegetables, meat, fish and a variety of breads. The women were enthusiastic about the fuel savings, since their firewood ration is just a few sticks every two weeks; when that ration was used up, they had to scrounge as they could for anything burnable--or do without eating.

   Women also noted other benefits: cleanliness, nutritional aspects, freedom from smoke inhalation, etc. One woman has already set up a small business solar-baking bread and selling it.

   The home visits and follow up meeting with each group were useful to correct

misunderstandings and build confidence among the new solar cooks. Already, the women see each other as sources of further cooking tips and adaptations.

3. Both interest in and use of solar cooking has spread throughout the community more rapidly than expected. From the first, our home visits to new solar cooks drew large crowds. As we moved from place to place, everyone came along until we were a great crowd of women, husbands, children, neighbors, etc. in a noisy, celebratory atmosphere. Each home visit was a public demonstration of solar cooking--so much the better because the cooks doing the demonstrating were the people's own peers and neighbors. Awareness is spreading daily, even when there are no home visits. Many of our trainees tell of an endless stream of neighbors coming to taste solar-cooked food, so much that the cooks themselves had little left to eat. They were good spirited about that, if not well fed!
4. We identified natural leaders from among the new solar cooks and recruited eight teams of teacher-trainees. They received extra training and worked alongside us to learn to lead their own workshops. Each new leader plans to teach about one workshop per week. Having solar cooking teachers from all the major ethnic groups here eliminates need for translators during workshops and will aid dissemination in general. With each workshop, there will be more solar cooks available to coach those starting out.
5. Jay worked with local craftspeople to design and construct solar cookers from a variety of local materials. Some of the Ethiopian refugees have already built several. We've arranged for a local company to produce CooKits in Kenya to meet the fast-growing demand now evident here in Kakuma.

Problems Encountered

Our problems in this initial phase has been logistics and language. The lack of predictable transportation in this remote area has made going anywhere or obtaining supplies an uncertain adventure. We suffered for a while from the lack of suitable pots with good lids. We think we have worked out a reliable supply for the next four months. We have found a good Kenya source for the bags used for insulating the pots.

Communication is always subject to misunderstanding; translating from one language to another merely multiplies the problems. We often worked with double translations in the same room--for example, from English to Armahic to Oromo. Now there are trainers from among our first 100 students who speak each of the major languages.

Conclusions

We recognize the success of the overall project must be measured with follow-up surveys to determine ongoing use and spread of the solar cookers and clear benefits to the users. However, the initial introduction has been a complete success. There is great interest among various UN and non-governmental agencies involved in managing the Kakuma camp.

Our success here has been largely thanks to the skillful, enthusiastic, hard work of our staff of Kenyan solar cooking teachers, especially Emily, Soshima, Faustine, Gladys, and Anna. Their key role here also underscores the value of SCI's long time strategy of empowering local people to disseminate solar cooking in their own countries.

By Fall we think we will be ready to share what we've learned--and also share some of the new trainers--with some of the other refugee camps in East Africa.

For questions or comments, contact
webmaster@solarcooking.org

http://solarcooking.org/95sep15a.htm

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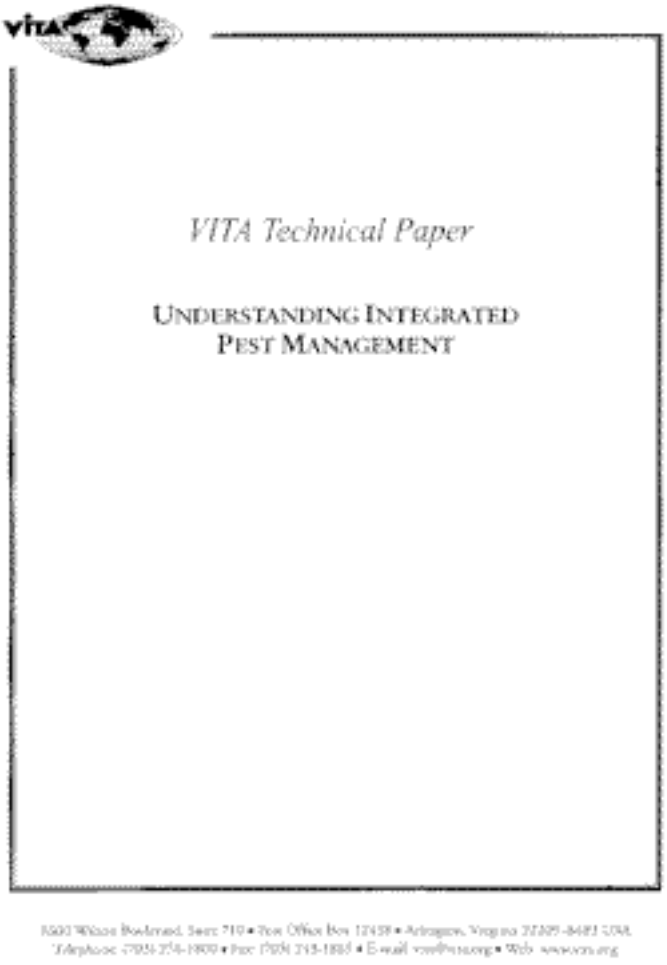

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home

RECYCLE-A-BIKE BIKE SALE

REVIEW OF SOLAR COOKER DESIGNS

Ashok Kundapur

Kalashree,Hayagreeva Nagara, Udupi 576 102, INDIA

This is a HTML version of the Review paper which appeared in TIDE, Vol 8, No. 1, March 1998 Page 1-37. This paper is now presented here in 16 parts.

This site helps you to find out if your design of Solar Cooker works or not. (The cartoon is from Prof Bernard's little book on Solar Cookers " La cuisson Solari Facile". Published by Jouyence Silence. France, reproduced here with his and publisher's permission)

Abstract

This review presents about **60 major designs** , 69 variations and over 100 drawings of solar cookers. Test data published by other researcher is compiled and a new set of parameters are suggested for testing Solar Cookers, reflectors, and insulating material. This compilation recommends do it-yourself box-type solar cookers incorporated in the house for the rural areas (type BDM 2, concept IX). For urban areas, the best suited design would be Prof. Bowman s design with slight modifications (Type MP 3a,or Concept IV). Another design for small towns, where smaller houses are more in number, is the roof-top water lens whose focus is suitably deflected to the bottom of the cooking vessel (Type LCA 3a, Concept VI).Of other viable designs Bernard's 'COOKIT' appears to be the best suited, other designs are also discussed. (**Update:** 6 more new designs have been added since this site was launched in June 1999, for details see at the end of this part and also in the respective sections) The Sheffler's Reflector is also becomming popular World over.

PLEASE NOTE:

- **The designs designated here as CONCEPTS I to XII were conceived during '80ies, but I do not claim any right over the same, these designs can be tried out without my prior permission. However I appreciate if I get a detailed report of the performance.**
- **This is an ACTIVE SITE, any Researcher or an Inventor may contribute/publish his/her design through this site.**
- **Where ever possible, all the new entries made after 6th June 1999 will be entered in parenthesis under the title of UPDATE.**

CONTRIBUTORS TO THIS SITE

- **BRETT WHITE of Australia, was the first contributor to this SITE. He has updated the folding type Parabolic cookers listed here under PC 8.**

- **DERIS JEANNETTE from USA is the second contributor. He has evolved 'CLEAR DOME SOLAR COOKERS'**

classified here under LCA 7. Hehas also presents several other interesting variations, all of which are for sale.

- **DAVID DELANEY of Canada, turns out to be the first critic of the site, and as per his advice, I have renamed the web page as my Homesite. He is concentrating on improving the transparent insulating cover, first suggested by Prof. Bernard and then modified by Prof. Barbara Kerr, more effective. His site should visited for more detailed information on various aspects of Solar Cooking . He has also introduced a new design called Inverted Box.**

- **QUINSTONE STOWELL from UK, is the fourth contributor to the site. He had detailed his project work undertaken at Peru and presents several guidelines for easier construction of parabolic solar Cookers.**

- **I am delighted to receive very nice words and a beautiful book from Prof. BERNARD, (off France), designer of most popular Solar Cooker 'COOKIT". The book is in French but fortunately details of his designs are presented by Solar Cooker International.**

- **Stoven has presented an interesting design called FUNNEL COOKERS, I would place it close to ' Cookit', and designate it as LCA 8.**

- **Prof. Paul Funk's SEAE Standards on testing Solar Cookers has been added just this month that is, October 2001. Active researchers who have tested the Solar Cookers using this method could please send me the details.**

Acknowledgements

The author acknowledges the help and encouragement extended by the **late Prof. P.S. Shivram**, Head, Department of Printing Technology and Energy Centre, MIT, Manipal , who was solely responsible for the publication of the earlier review in 1995. In fact the work on Solar Cookers was launched here at Udupi way back in 1975 and it was **Ms Janet Alarcon** of **VITA** and **Sri. G K Gopalakrishnan**, Chief Documentation officer, TERI , (then located at Mumbai) who not only enthused me forther but helped me by sending tons of information. And now, especially to **Dr. M C Shukla** of TERI, New Delhi, for having recognized this work and encourage compilation of this abridged and updated version, and getting it published in TIDE. I am also grateful to **Ms. Bev Blum**, Vice President, **Solar Cooker International**, USA. for encouraging me to put this paper on WEB. I am also grateful to **Prof. Sureshramana Mayya**, Department of Commerce, at our College for taking special interest in converting this paper into HTML format. (for other links see at the end of References)

PROLOGUE

(Please read this before you go further)

This site was launched in June 1999, since then over 18000 interested persons have visited the site, and many of them have spoken very high of it, I am ever grateful to them. Others have suggested changes which have been incorporated. New designs and works too have been added. But before one continues further I request them to read this prologue.

Many of the Solar Cooker Enthusiasts are still keen on fabricating perfect Parabolic reflectors! But this aspect has been dealt in detail under the section. Many of the Stalwarts like Prof. T. E. Bowman of Florida Institute of Technology, and also Prof. Roger Bernard of France have suggested using Plane mirrors in sted. I guess it would be much easier to do so. In this regard Sheffler's efforts, to use plane flat mirrors on a Parabolic confuguration are worth emulating

Remember the insulated Box of Box type Gosh Solar Cooker ?. Prof. Barbera Kerr and several others had suggested using paper balls, straw and a wide variety of materials for making the box and also the insulation to go in-between. Inventors like Patel (1981, Ref. 74,) had in fact suggested inverted Glass Jar in sted of a very heavy and combersome insulated Box. Later Prof. Bernard had suggested the use of such a Jar for his 'COOKIT' design. Glass Jars are costly and are prone to break, so Prof. Barbera Kerr used clear plastic bags to cover the cooking pots very successfully. Prof. Bowman too had realised the importance of the insulation of Cooking vessel and he had suggested FOAM GLASS boxes around cooking pots for the FIT designs. Recently Deris uses two such clear jars (Glass or heat resistant Polycarbonate jars), inverted over the cooking pots where the light is concentrated by a circle of ordinary mirrors! I guess the Solar Cooking can not be made

simpler than this design of Deris.

At this juncture,(in 1999) I wish to introduce the work being pursued by Mr. David Delaney of Canada. Taking the cue from Prof. Bernard, and Barbera Kerr he is attempting to improve this Glass Jar concept. Covering the Cooking pot with a Glass jar has two problems, handling the cooking pot and its contents become difficult, and condensation of moisture inside the glass container affects the transmission of solar light to the pot. So he suggests use of a upright jar of not more than 2 inches in diameter of the cooking pot. Use of a suitable collar of card board or more stable material for placing the pot into the jar, and also a cooking pot with a clear glass 'insulated' lid. I feel that these suggestions are very apt, but at the sametime find that the Glass jars of that type are rather costly upto Rs. 400 ($ 10) especially because Gosh type Solar Cookers of 2' x 2' were being sold in our country at Rs. 450 to 650! ($ 12 to 16 only). I do not suggest that the Box type of Cookers are better, but an attempt is needed to find a suitable material to cover the cooking pot.

Mr Diassana, an active Solar Cooker Enthusiast from Africa, brought out a simple plastic cover that had clear improvement over clear plastic bag. I have improved on this concept and the details are available in solar5 of this review site.

Ashok Kundapur

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Introduction

Solar energy is the primary source of energy for our Planet. Increased utilization of the same would result in an all-round benefit, both in terms of cleaner environment and monetary gain, for the individual users as well as the Nation. Use of solar energy would save a lot of time and money for the user and this could be effectively diverted for increased productive activities and monetary gains which means better living standards and overall prosperity. The Gujarat Energy Development Agency (GEDA 1979) calculates that the use of solar cookers by about 2000 families for 10 years would mean a saving of Rs 3.6 million in terms of reduced firewood consumption, or Rs. 100 million worth coal or Rs. 8.55 million worth kerosene (as per 1979 prices).

History

The history of solar cooking goes back to dim recess of antiquity. The use of solar power to ignite altar fires has been mentioned (Meinel, Meinel 1997). References indicate the use of sun rays to melt chemicals and metals. The very first solar furnace was fabricated in France by the famed naturalist George Louis Leclere Buffon (1707 1788). However, the first reference relating to solar cooking was that of Nicholas-de-Saussure (1740 1799). There are over 60 major designs of solar cookers, some of which are patented, and more than 100 variations. Of these, this review covers about 59 of the most important variations. The main purpose of this compilation is to present all possible major designs and their variations so as to prevent the solar cooker designer from wasting time on a design which has already been under the Sun. An attempt is made to cover most of the designs, but if there are any omissions then the designers may please send the details. Though the description of the cooker is brief, accompanying diagrams would fill the void. As regards dimensions, adequate guidelines are given in the respective sections, but for concentrating type the area should preferably be more than 1.5 sq. m, and in the case of box type, it should be around 0.7 sq. m.

The solar cookers presented in the review are classified under THREE categories:

- **Concentrator Type**
- **Box-type designs**
- **Indirect Types**

Ashok Kundapur

The Concentrator type, concentrate the sun s rays either on to the top or at the bottom of the cooking pot, was the pioneering design. Naturally maximum variations are found under this category and 28 designs are discussed here. The Box type design was one of the first solar cookers to appear under the sun, and is one of the popular designs now. Eleven major designs of this type are described here. The

Indirect type solar cookers are those that have collectors outside and the cooking area or plate is inside the house. About 11 exotic designs find place in this review (Chart I).

Recently Prof. Bernard's COOKIT is becomming popular and there are many variations of the design. Not to be left out, I have tried my hand at it too. The Gross design as well as the Transparent Cooking Cover for the vessels. You can learn more about it under solar5.htm.

(To day, the 4th April 2003, I am attempting to 'bookmark' the major designs to enable easier navigation. I am sure the reader will benifit from the same. So you can just click on to the hyper linked/Bookmarked leads to get to the desired design instantly)

TABLE I - SOALR COOKERS

Concentrator Type	Box-type designs	Indirect Types
LIGHT FROM ABOVE Water Lens & Lens Dome, **LIGHT FROM BELOW** ■ Spherical ■ Fresnel ■ Cylindro parabolic ■ Mirror plane ■ PARABOLIC ● Collapsible ● Rigid ❍ Asymmetrical ❍ Shallow ❍ Deep	● Without Mirrors ● With Mirrors ❍ Single Mirror ❍ Double Mirrors ❍ Three Mirrors ❍ Four Mirrors ❍ Four plus Four	❍ IDT 1 Whiller type ❍ 1a Stam Cooker ❍ 1b Bowman type ❍ 1c Venugopal type ❍ IDT 2 Chinese type ❍ 2a Nijaguna type ❍ IDT 3 Stam type ❍ IDT 4 Swet type ❍ IDT 5 Fraber type ❍ IDT 6 Winston CPC tpye ❍ IDT 7 Concept XII ❍ IDT 8 Chemical types ❍ IDT 9 Biogas ❍ IDT 10 Solar Hydrogen ❍ IDT 11 Solar Water Heater
(for details See Chart Ia)	(for details See Chart Ib)	

(**UPDATE** : Medved et.al., 'SOLAR BALL' under Spherical Concentrators S-2

Amith Kumar's Circular Box with Contored Mirror under BSM 2, Prof Sayiah Type under BSM 3, Prof. El Sebiis type under BSM 4, Fatangares type under BWM 7, Double Parabola under PRS 2,

Prof. Bernard's 'NEPLA' in under MP 3 are 7 new designs considerded in this first ed. of the web page)

Source:- TIDE., March 1998, 8-1, pp 1-37, For Comments, suggestions,contributions contact <

Ashok Kundapur

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For easy NAVIGATION use this chart.

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click here for comments received

For details regarding testing of solar cookers (International Standards) please click here

For Comments, suggestions,contributions contact <

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Centre for Rural Technology

INTRODUCTION

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The Centre for Rural Technology (CRT) is an autonomous private sector, professional development organisation. It is engaged in developing and promoting technologies effective in meeting the basic needs of the rural mass and improving their life support systems.

Since its establishment (August 1989), CRT has been actively engaged in up-grading traditional technologies and developing new technologies to make it more diversified and versatile to meet rural condition.

It has been promoting and disseminating technologies that emphasise the maximum use of local resources and self-help in dealing with rural needs, problems and prospects, and contribute towards empowerment of the rural communities.The Centre has also been involved in undertaking pilot demonstration projects, technology related feasibility and market studies, impact assessment and issue-based research activities.

- Collaborating Organisation
- Organization and Management
- Documentation Unit
- Newsletter
- Photo Collection

Centre for Rural Technology

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Breakthrough in Kenyan Refugee Camps

(items marked NEW! were added in the last 30 days)

Solar Cookers International (SCI) has been sponsoring extensive solar cooking work in Kenyan refugee camps. More than 15,000 families have attended workshops and returned home with their own solar cooker. Thanks to a new cooker design, it costs only US$10 to supply each of these families with a solar cooker, a black pot, a supply of trial food, and instruction on how to use their new cooker. Follow-up visits have revealed a high level of use. Families report now that they no longer have to trade their scarce rations for firewood, and thus have more food left to eat.

This page pulls together all the photos and articles we have on these exciting developments:

- Update March, 2002: Three Thousand More Families Solar Cook
- March, 2002: Kakuma project is runner-up for the prestigious Ashden Award for Renewable Energy

  You can listen to Margaret Owino discussing the project on the BBC program Network Africa.

- Solar Household Energy, Inc. is spreading this work to other countries including Turkey.
- Update April, 2001: Count on Solar Cooking
- Update December, 2000: Refugee Projects on Track
- Interaction recently published an article on SCI's work with solar cookers in refugee camps.
- Update August, 2000: Building on Strength
- Update April, 2000: Projects Clearly Valued

- Update December, 1999: East Africa Update
- Listen to "Letters from Kenya" where SCI trainers discuss the projects.
- Update April 2000: Projects Clearly Valued
- Update November 1999: Inside Kakuma
- Update August 1999: East Africa Coordinator Going Strong
- Update September 1997: Kakuma, Zimbabwe Project Update
- UNESCO Funds Solar Cooking Project in Zimbabwe
- An October '95 interview with the major Kakuma refugee camp trainers, Jay Campbell and Barbara Knudson
- An October '95 interview with Dr. Robert Metcalf on his return from trainings in Dadaab and other camps.
- Update for 1995
- Kakuma Refugee Solar Cooking Project--Report #1

(Cette page en Français) (Esta página en español)

For more information, contact Solar Cookers International -- Tel: (916)-455-4499

Solar Cookers and Social Classes in Southern Africa

William Noble Grundy

William Noble Grundy received his Bachelor of Science degree from Stanford's Symbolic Systems program in 1991. He is currently pursuing a doctorate in Computer Science from the University of California, San Diego.

INTRODUCTION

Once upon a time, perched atop the Drakensberg Mountains above the Republic of South Africa, there lay a tiny country called Lesotho. Lesotho (pronounced le-SOO-too) was inhabited by Basotho (singular "Mosotho") who farmed the mountainous terrain. One day, trekking over the crags, a group of foreigners arrived in the village of Thaba Tseka, in the center of Lesotho. They carried with them 45 odd-looking boxes which they said could use the light of the sun to cook food. The boxes were a gift for the people of Thaba Tseka.

I could write an essay about why the people of Thaba Tseka did not adopt the solar box cookers brought to them by those well-meaning foreigners from the University of Cape Town. But I won't. First, such an essay has already been written. Second, I am no expert. I am avoiding writing this story in standard academese -- in the passive voice, with lots of footnotes and three-syllable words -- in order to avoid giving anyone the impression that I might know a lot about the subject of solar box cooker use in Lesotho.

You might justifiably wonder why, if I'm not all that knowledgeable about the subject, I am bothering to write this article (or, more to the point, why you are bothering to read it). Remember: I didn't say that I am ignorant, only that I'm not an expert. I did live in Lesotho for two years, from December of 1991 to December of 1993, during which time I taught high school math, physics and literature at a high school in Mafeteng District in southern Lesotho. I hope that, even though I'm no Mosotho, my first-hand experience in the country can provide some insight into the difficulties involved in disseminating solar box cookers in Lesotho.

One last disclaimer before I begin: in keeping with my get-you-thinking (as opposed to construct-an-ironclad-argument) approach to this paper, some of the distinctions and definitions I discuss may be fuzzy. For example, I am going to talk about three types of people in Lesotho: rural housewives, urban sophisticates, and wanna-be's. I claim neither that these three groups

constitute an exhaustive description of Basotho nor even that they represent meaningful sociological groups. I discuss these three groups because, based upon my necessarily somewhat limited experience in Lesotho, these three *ad hoc* groups seem most relevant and useful for discussing the dissemination of solar box cookers. Eventually I hope to persuade you that, of the three groups of people in Lesotho whom I have mentioned -- rural women, urban sophisticates, and the wanna-be's -- the third group is most likely to adopt solar box cookers; however, even they probably will not do so because they tend to emulate the West, and we don't use solar box cookers.

RURAL WOMEN

We start where the people from the University of Cape Town started, in the mountains of Lesotho. I should explain that the term "in the mountains" is relative. Everywhere in Lesotho is in the mountains: Lesotho has the highest low-point of any country in the world. My school, Mt. Tabor High School, was located in the lowlands, even though its elevation was 1750 m (5750 ft.). For the purposes of this discussion, people who live in the mountains are those who live far from any main road, who live without vehicles or electricity or running water.

Without a doubt, rural women need solar box cookers more than anyone else in Lesotho. The mountains there are almost completely devoid of trees, so that the average woman spends two hours a day gathering wood. Solar box cookers could save such women those two hours each day. Even the women who cook on kerosene stoves could benefit from solar box cookers: especially in a rural environment, money for kerosene is rare indeed. And sometimes the shops in the mountains are out of kerosene for up to two months.

An obvious additional benefit of solar box cooker use would be the preservation of what few trees remain in Lesotho; unfortunately, such a goal does not make sense to many Basotho. I am sure that, if there were a competing need for trees -- if, for example, the trees were needed as building material -- then many Basotho would have an easier time accepting that solar box cookers were necessary in order to preserve the trees for later use. However, the goal of saving trees *for the trees' sake* is a

foreign idea. A friend of mine, Megan McCarthy, who was teaching at a high school near mine, mentioned in class one day Lesotho's lack of trees. The students disagreed with her, and going to the window, they pointed out at the windswept plains: "Look, there's a tree over there," they said, "and another one over there. . . " For Megan's students, having four or five trees in sight was plenty. No more were necessary. Once when I expressed to a student my delight at having located a nest of an endangered bird, the bald ibis, on the mountain where we lived, I found myself having to explain the concept of an "endangered species" to him. When Tsepo understood that this particular species of bird might no longer exist in a few years, his first question was, "Are they useful?" If no one needs bald ibises for anything, Tsepo reasoned, why bother to preserve them?

This lack of an ecological perspective is a particularly large stumbling block for a group such as Solar Box Cookers International, which seeks to increase the use of solar box cookers worldwide. S.B.C.I. is fundamentally an environmental organization. One could, I suppose, argue that the foreigners who bring solar box cookers to Lesotho do so because they are concerned that the Basotho women are doing so much extra work gathering wood and spending so much extra money on kerosene. But realistically, the primary reason for outsiders to care about solar box cooker use in Lesotho is precisely because those outsiders have developed a global ecological perspective which includes Lesotho. Destruction of the local environment in Lesotho is also destruction of the global environment in which we all live. Unfortunately for the outsiders, crossing the mountains with their truckloads of ill-fated solar box cookers, concern for the environment is a post-industrial concern: in most cases, people do not begin to seriously worry about the environment until they have reached a certain stage of development. The Basotho are not going to start caring about saving trees until they can stop worrying about erecting the telephone poles leading to their homes.

The second stumbling block is more obvious than the rural Basotho's lack of global environmental concern: people tend to resist innovation. In particular, people in rural, traditional cultures resist innovation introduced by outsiders. The intrepid folk from the University of Cape

TABLE 1

FACTOR	GROUP
	Rural Women
Inexpensiveness	Yes
Ease of Use	Yes
Environmental Concern	No
Openness to New Ideas	No
Susceptibility to Advertising	No

Town who so valiantly trucked their 45 solar box cookers to Thaba Tseka discovered the Basotho's unwillingness to change. In fact, that resistance to outside ideas is so strong that one man, Anthony Scott, told me that foreigners simply cannot bring solar energy to Lesotho's villages. Anthony was born in Lesotho and lives there now, running a general store in the village of Mpharane. He is a strong proponent of solar energy use in Lesotho, yet in the few hours in which I met with him, he repeatedly assured me that solar box cookers will not, *cannot* be disseminated in Lesotho by foreigners. The problem is particularly acute for people who come to Lesotho for a brief stint of a few months or a year or two; however, even for Anthony, who lives in Lesotho permanently, the distrust of foreign ideas is too strong. The need for solar box cookers must come from the Basotho, rather than from well-meaning outsiders.

In America or any other industrialized nation, such needs can be created through advertising. For obvious reasons, however, advertising cannot succeed in the mountains of Lesotho. The infrastructure and technology simply do not exist. You can't make television commercials for a place without televisions. No one in rural Lesotho gets magazines or newspapers. There are no billboards. In addition to their distrust of foreign ideas, the people in the mountains of Lesotho are not easily reachable by way of normal advertising techniques.

I may have given you the impression, two paragraphs ago, that Anthony Scott is completely pessimistic about the spread of solar box cookers in Lesotho. He isn't. However, before we start talking about what he is doing, let's review the show so far in Table 1.

I have mentioned five different criteria upon which to judge the likelihood that people will adopt solar box cookers. Women in the mountains of Lesotho might be convinced to use solar box cookers because they are cheaper than kerosene and easier than gathering wood. On the other hand, rural Basotho tend to lack the global perspective that makes tree preservation a priority. Furthermore, they are suspicious of innovation and not easily reachable through advertising.

URBAN SOPHISTICATES

One way to change the three "Nos" in Table 1 into "Yeses" is to change the target market. Anthony Scott, although he lives relatively far from the city, aims his current efforts at a relatively sophisticated urban crowd. He hopes to establish a school in Mpharane, his home, at which Basotho will teach other Basotho about solar energy. His plans, however, are not limited solely to the introduction of solar box cookers, and I am going to explain why I think his efforts are more likely to meet with success in advanced technologies such as photovoltaic cells.

Before that discussion, however, I'd like to introduce you to at least one urban sophisticate. In the previous section about rural women, I did not have a lot of primary experience upon which to draw. My school was not very far back in the mountains. On the other hand, I did make some friends in the capital, Maseru. Palesa Moitse is a 26-year-old Mosotho lawyer living in Maseru. The daughter of university professors, she grew up going to international schools, sometimes in Lesotho and sometimes in Swaziland. She got her law degree at the National University of Lesotho and, when I was in Lesotho, worked for an insurance firm in Maseru. Not only does Palesa's apartment have running water and electricity, it also has a television, a refrigerator and an electric oven.

Clearly, a person like Palesa does not need a solar box cooker. Yes, she is concerned about the environment. Yes, she is open to new ideas. Yes, she is susceptible to advertising. But a solar box cooker is simply inappropriate for her lifestyle. Although it might be a bit cheaper than her electric stove, the cost difference is negligible. Furthermore, she would rarely have the time nor a place in which to use a solar box cooker. By the time she gets home from work at 5:00 p.m., the sun is low in the sky. If anything, Palesa could use a microwave oven, not a solar box cooker. Solar box cookers are not technologically advanced enough for the urban sophisticates.

One solution -- the solution which Anthony Scott plans to pursue -- is to target the sophisticated end of the market with upscale versions of solar box cookers and then hope

for a trickle-down. Anthony has developed a solar box cooker made of wood, sheet metal and glass which will withstand Lesotho's harsh climate. That model costs about R200 (US $60). However, he has plans underway to develop a R1000 (US $300) model which would do indoor cooking using CPCs (solar cells which would allow energy to be transmitted from an outdoor, sunlight-exposed location to the cooker indoors). The way to get an idea accepted, he claims, is to get the rich people to do it first. Since rich people don't want to buy standard solar box cookers, more advanced models must be made available. After they have started using solar energy, others will emulate them. The innovation will spread outward from the cities.

I have difficulty imagining exactly how that trickle-down will occur, but the difficulty may be in my imagination rather than in the theory itself. At first, the idea that Palesa Moitse's buying a CPC oven in Maseru will lead eventually to the adoption of solar box cookers by women in Thaba Tseka seems absurd. However, if we allow that the trickle-down process from the urban sophisticates to rural women may take several generations, then I will grant that, perhaps, such a process might occur.

I only make that concession, however, because I have a more telling card to play: I don't believe that Palesa Moitse or people like her are going to buy even the most technologically advanced, CPC-based solar cookers. After all, not much separates Palesa's day-to-day lifestyle from that of a middle-class American. For the same reasons that solar energy has failed to catch on in America, it will fail to catch on among the urban elite in Lesotho. The savings in money and the preservation of the environment are not strong enough arguments in favor of solar cookers to outweigh the inconvenience of even the most advanced models.

TABLE 2

FACTOR	GROUP
	Urban Sophisticates
Inexpensiveness	No
Ease of Use	No
Environmental Concern	Yes
Openness to New Ideas	Yes
Susceptibility to Advertising	Yes

THE WANNA-BEs

It's time to own up, though: I don't imagine that anyone really expects the urban sophisticates of Lesotho to adopt solar box cookers. In fact, I've been beating on a straw man throughout most of the previous section of this paper. Anthony Scott does not plan to target the Palesa Moitse's of Lesotho. I have included the discussion of urban sophisticates in order to make clear that there are people in Lesotho for whom solar energy is inappropriate or, at least, very unlikely to catch on. The description of urban sophisticates also provides a foil for the next group of people whom I will discuss. This group, sandwiched between the rural people and the urban sophisticates, consists of the many people in Lesotho who want to be urban sophisticates but who have not achieved the required level of income and education. For lack of a better name, I will call this large group of people the "wanna-bes."

Virtually every one of the students and teachers with whom I worked in Lesotho was a wanna-be. For that matter, virtually everyone I know in America is a wanna-be: they want to be richer, live in a better neighborhood, drive a snazzier car. I am not making a judgement about those desires, only pointing out that Americans do not have a monopoly on such covetousness. In fact, the division between urban sophisticates and wanna-bes is rather artificial; a more accurate set of labels might be "the rich ones" and "the not-so-rich ones." Certainly the rich ones, like rich people anywhere, want to be richer. The teachers at Mt. Tabor High School are some of the not-so-rich ones. They often talked about the electronic equipment they had or wanted: Ntate Phenethe spoke of the television set he kept at his mother's house; Ntate Mqathazane carried his shortwave radio around with him everywhere; Ntate Kiwanuka bought my Minolta single-lens reflex camera even though it was far more complicated than he would ever need. Similarly, the universal goal among the students at Mt. Tabor High School is to have what they call a "bright future." I discussed the phrase "bright future" with my literature class one day. After a brainstorming session we had a list of twenty or so sub-goals which comprised what they considered to be a bright future: owning a nice car, having a house with ten rooms, eating meat as often as they

wished, wearing expensive clothing and so on. However, after discussing the list with the class, we came to the conclusion that all of their goals could be summarized in one word: money.

Of the three groups of Basotho whom I have discussed, this third group -- the type of people with whom I spent most of my time in Lesotho -- is most likely to adopt solar box cookers. First, they are fairly open to new ideas. Certainly the notion of progress is not as strong among my students as it is among their counterparts in Machabeng, the international school in Maseru; however, almost all of my students unflinchingly considered development, that is, Westernization, in any form to be an improvement. In keeping with that belief, they were as open as any American teenager to influence by advertising. Admittedly, the advertising media does not inundate them nearly as completely as in the States, but what little advertising does reach them, in magazines and by radio, clearly affects them. I remember two form E (17- or 18-year-old) boys, Hlao Mothibi and Makhahlane Phoolo, perusing one of my copies of *Newsweek* magazine and pausing only to marvel at the automobile advertisements. And clearly the white models the girls had seen in product advertisements had affected their sense of beauty: over and over I had girls tell me how much they wished they had my long hair. One girl, Anicia Paanya, even wrote in an essay about how she wanted to go to South Africa to have her nose "removed" so that she could get a "nice, sharp, plastic one." Thus, not only are the wanna-be's relatively willing to accept outside ideas, they also are accessible by and vulnerable to standard advertising techniques.

However, as I've already mentioned, the primary factor which separates the wanna-be's from the urban sophisticates is money. For the purposes of this discussion, the wanna-be's are the ones for whom the cost of kerosene or gas is a real cost. Remember, the wanna-be's are the ones who want to get rich; they don't want to spend extra money on kerosene or gas if they can avoid it. For Palesa Moitse, her financial concerns centered around getting capital together to start a small business; for Anicia Paanya, before she can pay for her longed-for plastic surgery, she has to worry about paying for food, clothes and a place to live. She would be very happy to save the

R20 ($6) per month that her family normally spends on kerosene.

The other relevant difference between urban sophisticates and wanna-be's is environmental awareness. The only vegetarian Mosotho I've ever met was a student from Machabeng High School in Maseru. To the typical Mosotho, vegetarianism borders on the absurd. I once tried to explain to `Me `Mampho, one of the teachers at Mt. Tabor High School, why my brother is a vegetarian. I patiently explained the difference in production between an acre of land grazed by cattle and an acre of land planted with crops. I assumed that the need to provide more food from a given quantity of land, especially in an over-grazed, quickly eroding country like Lesotho, would seem pressing. `Me `Mampho's response, on the contrary, was something like, "Why would anyone want to think about things like that?" As I mentioned earlier, concern for the environment comes only after people no longer have to be concerned about their basic needs.

In the (almost) final analysis, then, the group of people who aspire to wealth but who have not yet attained it seem the most appropriate target group for solar box cookers. These people are open to new ideas, are susceptible to advertising and, most importantly, they would be attracted to the savings possible through the use of solar box cookers.

TABLE 3

FACTOR	GROUP		
	Rural Women	Urban Sophisticates	Wanna-be's
Inexpensiveness	Yes	No	Yes
Ease of Use	Yes	No	No
Environmental Concern	No	Yes	No
Openness to New Ideas	No	Yes	Yes
Susceptibility to Advertising	No	Yes	Yes

Looking at Table 3, you will notice that I have so far

ignored one of the "Nos" in the wanna-be column. I talked about their lack of environmental concern, but what about the difficulties involved in the day-to-day use of solar box cookers? Those difficulties were the primary obstacle to the adoption of solar box cookers by the urban sophisticates. What about for the wanna-bes? Unfortunately, the drawbacks involved in using solar box cookers -- having to use them outdoors being the main one -- do not disappear unless people buy expensive models. That option, however, effectively destroys the savings in fuel costs, savings which made the solar box cookers attractive to the wanna-bes in the first place. The gist, then, is this: the difficulty in using solar box cookers is a major stumbling block in their adoption by wanna-bes. Admittedly, the difficulty is not as pronounced as for the urban sophisticates: Palesa Moitse has less time and less space in which to use a solar box cooker than `Me `Mampho does. Nonetheless, `Me `Mampho is going to weigh the primary advantage -- savings -- against the primary disadvantage -- difficulty of use -- before she buys a solar box cooker.

In weighing these two options, `Me `Mampho will include, consciously or unconsciously, one other consideration, a consideration not listed in the table above. When deciding whether to buy a solar box cooker, many Basotho will ask themselves: what do white people do? I encountered a lot of racism in Lesotho, some against Boers, some against Indians, some against Chinese. But the most common form of racism among the Basotho was against themselves. `Me `Mampho, as well as several other people, told me that Basotho are lazy. Moliehi Malephane once tried to convince me to reduce a homework assignment. I told her that I'd had to do a similar assignment when I was in school. "You're different," she replied: you are white. White people, I was repeatedly told, are clever. They are also beautiful; that's why Anicia Paanya wants a sharp nose. One student, Palesa Mokotjo, assured me that God loves white people more than blacks. Several students on separate occasions unabashedly told me that they wished they were white. Unfortunately, the lifestyle which most Basotho long for is not that of a wealthy Mosotho; it is the lifestyle, real or imagined, of a wealthy white person. Therefore, many Basotho will ask themselves before buying a solar box cooker, "Is this going to make me seem more advanced?"

Will it, like Ntate Mqathazane's shortwave radio, put me closer to my Westernized goals, or will people call me a "khoho oa ntlo" (a home chicken; i.e., a country bumpkin) for having this piece of equipment around my house? Every several months, the students at Mt. Tabor High School watch a movie on video tape--always an American movie. Only when they see solar energy being used on the set of *Commando*, *American Ninja*, or *Rocky IV* will they really want solar box cookers for themselves.

CONCLUSION

In the end, unfortunately, the outlook for solar box cooker use in Lesotho is bleak. Several projects have already targeted the people who need solar box cookers the most, the rural women. Those projects have failed for complex reasons involving the resistance of traditional cultures to invasion by foreign innovation. On the other hand, no one expects the wealthy members of Basotho society to adopt solar box cookers, any more than we expect solar box cookers to catch on among middle class Americans. That leaves the majority of Basotho, those people who aspire to wealth but who have not yet attained it. Such people are far more open to new ideas than are the people living in remote areas of the mountains. Furthermore, for many of the members of this wanna-be group, solar box cookers represent a real savings in fuel costs. However, those people are going to have to be convinced that the benefits of using solar box cookers outweigh their inconvenience. More importantly, the majority of Basotho will be willing to adopt only those innovations which are perceived as being sufficiently Western. The Basotho tend to model their development after industrialized nations such as the United States. It will be difficult indeed to convince them that our example is not one to be followed.

...the majority of Basotho will be willing to adopt only those innovations which are perceived as being sufficiently Western.

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Cooking with the sun
Chilean village's experiment with solar ovens offers alternative to widespread deforestation

Casey Woods, Chronicle Foreign Service

Thursday, July 26, 2001
San Francisco Chronicle
CHRONICLE SECTIONS

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Villaseca, Chile -- Lucila Rojas remembers the days when she and her neighbors risked their lives to cook a hot meal over a wood-burning stove.

"We had to steal firewood, because there was no longer any left in the places where you could freely look," she said. "Sometimes we were chased (by landowners), even by gunshots. I was fed up. I didn't want any more war."

So in 1989, Rojas, who lives in the arid and deforested Elqui Valley, agreed to become one of four women in this northern village of 300 residents to allow researchers from the University of Chile to place a solar oven in her home. "We were guinea pigs," she said.

When the project coordinators returned after four months to take the ovens back, Rojas protested and organized local women to raise funds for a workshop to make solar ovens. With $700 they earned selling everything from empanadas (meat pastry) to used clothing, they built 33 solar ovens and have been using them ever since.

Today, Villaseca's ovens are a novelty in a nation with just 10,000 solar energy panel systems. In fact, the village is the only place in Chile where virtually all residents cook with solar power. Blessed with an average of 310 days of sunshine a year, the area is ideally situated to harness the sun's potential and solve a dramatic problem.

Firewood, the source of one-fifth of Chile's energy, takes an enormous toll on the nation's environment. Native forests, devastated by a constant assault, provide 60 percent of the wood. The Forestry Institute of Chile calculates that approximately 132,900 acres of forest are destroyed annually for firewood.

A 1995 Central Bank report noted that Chile's remaining old growth forests could disappear within 30 years if the current deforestation rate continues.

According to the Latin American Energy Organization, headquartered in Ecuador, 32 percent of the region's energy is derived from firewood, virtually the only source of energy for many rural poor. As a result, many environmentalists believe solar ovens are an obvious solution to help reduce deforestation. Yet, introduction of the ovens throughout the region has been limited.

MONEY NEEDED

"It is all about funding," said Shyam S. Nandwani, who heads the solar energy laboratory at the National University of Costa Rica and gives seminars on solar ovens. "If campesinos (peasants) don't have the financial means to buy materials, they can't implement the technology."

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Pedro Serrano, an environmental activist from Santiago and one of the Villaseca project's original planners, estimates there are 300,000 potential users of solar ovens in the northern Chile, and a total switch to solar ovens would save more than 2 million tons of brush and kindling annually, as well as about $60 million a year in lost labor time.

"Before, one person in every family dedicated all day, every day, to search for firewood," said Serrano. "That's ridiculous."

Not all Villaseca residents shared the initial enthusiasm for solar ovens. Some insisted that food cooked with solar energy caused cancer, claims that sparked a wave of concern.

The skeptics, however, were discredited after university researchers found that food cooked in solar ovens lacked traces of carbon monoxide typically found in meals cooked with gas or on wood-burning stoves. The change to solar ovens also led to an improved diet.

"Before we ate a lot of oils and fats, but since you can't fry in these ovens, our diet is much healthier," said Veronica Duran, Rojas' 24-year-old daughter.

Duran says villagers placed the first ovens in the sunniest part of their patios, since they assumed that was the best spot. The reality, however, was more complicated. The oven had to be constantly turned to follow the sun, and the light had to be focused to maximize its power. Moreover, the original ovens were large, making them awkward to shift.

EVOLVING DESIGN

So necessity converted Rojas and her husband, Aurelio Campos, into designers. Over the years, the husband-wife team painstakingly altered the design of the ovens to make them easier to use. "We have improved the ovens a great deal, but the design is still in diapers," said Rojas.

It took two years of experiments to give birth to an oven that could cook for 30 people, which led to the idea of opening a village restaurant last year.

With a $10,000 grant from the U.N. Program of Development, 26 Villaseca families formed an organization called the Association of Solar Artisans of Villaseca, which now runs the aptly named Restaurant Solar.

The restaurant's kitchen looks like a school science experiment -- 10 orange boxes sit in a line atop a staggered row of tables. Wide flaps inlaid with metallic sheets open to the sky, reflecting light into the boxes' dark interiors.

Although the restaurant opened only 11 months ago and diners must travel over a bumpy dirt road to its hillside location, it is already a landmark. On weekends, about 60 customers a day come to savor its specialties: fresh bread; cazuela, a meat stew; and leche asada, or flan, for dessert. It takes two hours to bake bread and about three hours to cook stew.

Sometimes, groups of as many as 40 people are turned away since the restaurant seats only 24 diners at a time. Its organic garden can't keep up with the demand. The majority of patrons are foreign tourists on package tours.

HIGH PRAISE

"It's the best meal we've had (in Chile)," said Mark Matthews, a 25-year- old New Zealander.

The solar business venture is so unusual that Chilean fire regulations have yet to adapt to alternative energy. To comply with fire safety rules, a local official charged with

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enforcing safety permits demanded that the restaurant construct a chimney-like chute to extract smoke. Solar ovens, which are built outside, don't produce smoke.

In the meantime, villagers say their main goal is to spread the alternative- technology gospel. Several have already extolled the virtues of solar ovens on prime time television programs and have fielded calls from other small villages asking for advice on how to build the ovens.

"The idea is to show the world the wonders of solar energy, not just to Chile and its people but to all those (international) organizations that could finance solar energy projects for people with scarce resources," said Rojas.

In Costa Rica, Nandwani says, funding for solar ovens generally comes from international humanitarian organizations such as the United Nations. He says governments rarely pick up the tab.

Environmentalist Serrano, however, doesn't find that surprising.

"The major investors are only interested in alternative energies that have a controllable energy flow, because they profit by selling that electricity," he said. "An unplugged user is a menace to the market."

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Recent Advances in Solar Water Pasteurization

Boiling isn't necessary to kill disease microbes

The main purpose of solar cookers is to change sunlight into heat which is then used to cook foods. We are all familiar with how successful solar cookers are at cooking and baking a wide variety of foods. In this article I want to consider using the heat in solar cookers for purposes other than cooking. My main focus will be solar water pasteurization, which can complement solar cooking and address critical health problems in many developing countries.

The majority of diseases in developing countries today are infectious diseases caused by bacteria, viruses, and other microbes which are shed in human feces and polluted water which people use for drinking or washing. When people drink the live microbes, they can multiply, cause disease, and be shed in feces into water, continuing the cycle of disease transmission.

Worldwide, unsafe water is a major problem. An estimated one billion people do not have access to safe water. It is estimated that diarrheal diseases that result from contaminated water kill about 2 million children and cause about 900 million episodes of illness each year.

Boiling contaminated water

How can infectious microbes in water be killed to make the water safe to drink? In the cities of developed countries this is often guaranteed by chlorination of water after it has been filtered. In developing countries, however, city water systems are less reliable, and water from streams, rivers and some wells may be contaminated with human feces and pose a health threat. For the billion people who do not have safe water to drink, what recommendation do public health officials offer? The only major recommendation is to boil the water, sometimes for up to 10 minutes. It has been known since the time of Louis Pasteur 130 years ago that heat of boiling is very effective at killing all microbes which cause disease in milk and water.

If contaminated water could be made safe for drinking by boiling, why is boiling not uniformly practiced? There seem to be five major reasons: 1) people do not believe in the germ theory of disease, 2) it takes too long, 3) boiled water tastes bad, 4) fuel is often limited or costly, 5) the heat and smoke are unpleasant.

Some examples of the cost of boiling water are worth mentioning. During the cholera outbreak in Peru, the Ministry of Health urged all residents to boil drinking water for 10 minutes. The cost of doing this would amount to 29% of the average poor household income. In Bangladesh, boiling drinking water would take 11% of the income of a family in the lowest quartile. In Jakarta, Indonesia, more than $50 million is spent each year by households for boiling water. It is estimated that in the city of Cebu in the Philippines, population about 900,000, about half the families boil their drinking water, and the proportion is actually higher for families that obtain their water from an unreliable chlorinated piped supply. Because the quantities of fuel consumed for boiling water are so large, approximately 1 kilogram of wood to boil 1 liter of water, and because firewood, coal, and coke are often used for this purpose, an inadequate water supply system significantly contributes to deforestation, urban air pollution, and other energy-related environmental effects.

If wood, charcoal, or dung is used as fuel for boiling water, the smoke creates a health hazard, as it does all the time with cooking. It is estimated that 400 to 700 million people, mainly women, suffer health problems from this indoor air pollution. As a microbiologist, I have always been perplexed as to why boiling is recommended, when this is heat far in excess of that which is necessary to kill infectious microbes in water. I presume the reason boiling is recommended is to make sure that lethal temperatures have been reached, since unless one has a thermometer it is difficult to tell what temperature heated water has reached until a roaring boil is reached. Everyone is familiar with the process of milk pasteurization. This is a heating process which is sufficient to kill the most heat resistant disease causing microbes in milk, such as the bacteria which cause tuberculosis, undulant fever, streptococcal infections and Salmonellosis. What temperatures are used to pasteurize milk? Most milk is pasteurized at 71.7° C (161° F) for only 15 seconds. Alternatively, 30 minutes at 62.8° C (145° F) can also pasteurize milk. Some bacteria are heat resistant and can survive pasteurization, but these bacteria do not cause disease in people. They can, however, spoil the milk, so pasteurized milk is kept refrigerated.

There are some different disease microbes found in water, but they are not unusually heat resistant. The most common causes of water diseases, and their heat sensitivity, are presented in Table 1. The most common causes of acute diarrhea among children in developing countries are the bacteria Escherichia coli and Shigelia SD. and the Rotavirus group of viruses. These are rapidly killed at temperatures of 60° C or greater.

Solar water pasteurization

As water heats in a solar cooker, temperatures of 56° C and above start killing disease-causing microbes. A graduate student of mine, David Ciochetti, investigated this for his master's thesis in 1983, and concluded that heating water to 66° C in a solar cooker will provide enough heat to pasteurize the water and kill all disease causing microbes. The fact that water can be made safe to drink by heating it to this lower temperature—only 66° C—instead of 100° C (boiling) presents a real opportunity for addressing contaminated water in developing countries.

Testing water for fecal contamination

How can one readily determine if the water from a well, pump, stream, etc. is safe to drink? The

common procedure is to test the water for bacterial indicators of fecal pollution. There are two groups of indicators which are used. The first is the coliform bacteria which are used as indicators in developed countries where water is chlorinated. Coliform bacteria may come from feces or from plants. Among the coliform bacteria is the second indicator, Escherichia coli. This bacterium is present in large numbers in human feces (approximately 100,000,000 per gram of feces) and that of other mammals. This is the main indicator used if water is not chlorinated. A water source containing 100 E. coli per 100 milliliters poses a substantial risk of disease.

The standard method of testing water for the presence of coliforms and E. coli requires trained personnel and a good laboratory facility or field unit which are usually not present in developing countries. Thus, water supplies are almost never tested.

A new approach to testing in developing countries

In 1987, the Colilert MPN Test (CLT) was introduced as the first method which used a defined substrate technology to simultaneously detect coliforms and E. coli. The CLT comes as dry chemicals in test tubes containing two indicator nutrients: one for coliforms and one for E. coli. The CLT involves adding 10 ml of water to a tube, shaking to dissolve the chemicals, and incubating at body temperature for 24 hours. I prefer incubating tubes under my belt against my body. At night I sleep on my back and use night clothes to hold the tubes against my body.

If no coliform bacteria are present, the water will remain clear. However, if one or more coliforms are present in the water, after 24 hours their growth will metabolize ONPG and the water will change in color from clear to yellow (resembling urine). If E. coli is among the coliform bacteria present, it will metabolize MUG and the tube will fluoresce blue when a battery-operated, long-wave ultraviolet light shines on it, indicating a serious health hazard. I have invited participants at solar box cooker workshops in Sierra Leone, Mali, Mauritania, and Nepal to test their home water supplies with CLT. One hundred and twenty participants brought in samples. In all four countries, whether the water was from urban or rural areas, the majority of samples contained coliforms, and at least half of these had E. coli present. Bacteriological testing of the ONPG and MUG positive tubes brought back from Mali and Mauritania verified the presence of coliforms/E. coli in approximately 95% of the samples. It is likely that soon the Colilert MPN test will be modified so that the test for E. coli will not require an ultraviolet light, and the tube will turn a different color than yellow if E coli is present. This will make the test less expensive and easier to widely use in developing countries to assess water sources.

Effect of safe water on diarrhea in children

What would be the effect if contaminated water could be made safe for drinking by pasteurization or boiling? One estimate in the Philippines predicts that if families using moderately contaminated wells (100 E. coli per 100 ml) were able to use a high-quality water source, diarrhea among their children would be reduced by over 30%. Thus, if water which caused a MUG (+) test were solar pasteurized so it would be clear, this would help reduce the chance of diarrhea, especially in children.

Water pasteurization indicator

How can one determine if heated water has reached 65° C? In 1988, Dr. Fred Barrett (USDA, retired) developed the prototype for the Water Pasteurization Indicator (WAPI). In 1992, Dale Andreatta, a graduate engineering student at the University of California, Berkeley, developed the current WAPI. The WAPI is a polycarbonate tube, sealed at both ends, partially filled with a soybean fat which melts at 69° C ("MYVEROL" 18-06K, Eastman Kodak Co., Kingsport, TN 37662). The WAPI is placed inside a water container with the fat at the top of the tube. A washer will keep the WAPI on the bottom of the container, which heats the slowest in a solar box cooker. If heat from the water melts the fat, the fat will move to the bottom of the WAPI, indicating water has been pasteurized. If the fat is still at the top of the tube, the water has not been pasteurized. The WAPI is reusable. After

the fat cools and becomes solid on the bottom, the fish line string is pulled to the other end and the washer slides to the bottom, which places the fat at the top of the tube. Another pasteurization indicator has been developed by Roland Saye which is based on expansion of a bi-metal disc which is housed in a plastic container. This also shows promise and is in the early testing stages.

The WAPI could be useful immediately for people who currently boil water to make it safe to drink. The WAPI will clearly indicate when a safe temperature has been reached, and will save much fuel which currently is being wasted by excessive heating.

[Editor's note: Using Beeswax & Carnauba Wax to Indicate Temperature: In SBJ #15 we discussed using beeswax, which melts at a relatively low 62º C, as an indicator of pasteurization. We have now found that mixing a small amount of carnauba was with the beeswax (~1:5 ratio) raises the melting temperature of the beeswax to 70º - 75º C. Carnauba wax is a product of Brazil and can be bought in the US at woodworking supply stores. Further testing needs to be done to confirm that the melting point remains the same after repeated re-melting. Write to webmaster@solarcooking.org and we will send you a small amount of carnauba wax to experiment with.]

Different strategies for solar water pasteurization

The solar box cooker was first used to pasteurize water. David Ciochetti built a deep dish- solar box cooker to hold several gallons of water. At this time of the year in Sacramento, three gallons could be pasteurized on our typical sunny days.

Dale Andreatta and Derek Yegian of the University of California. Berkeley, have developed creative ways to greatly increase the quantity of water which can be pasteurized, as we will hear

about at this conference.

I am also excited about the possibility of pasteurizing water using the simple solar panel cookers. By enclosing a dark water container in a polyester bag to create an insulating air space, and by using lots of reflectors to bounce light onto the jar, it is possible to pasteurize useful amounts of water with a simple system. It takes about four hours for me to pasteurize a gallon of water in the summer with the system I am using. Solar panel cookers open up enormous possibilities for heating water not only for pasteurization, but also for making coffee and tea, which are quite popular in some developing countries. The heated water can also be kept hot for a long time by placing it in its bag inside an insulated box. In the insulated container I use, a gallon of 80° C water will be approximately 55° C after 14 hours. Water at a temperature of 55° C will be about 40° C after 14 hours, ideal for washing/shaving in the morning.

I will close with some advice from the most famous microbiologist, who pioneered the use of vaccinations in the 1890s: Louis Pasteur. When he was asked the secret of his success, he responded that above all else, it was persistence. I will add that you need good data to be persistent about, and we certainly have that with solar cookers; the work in Sacramento, Bolivia, Nepal, Mali, Guatemala, and wherever else the sun shines. Continued overuse of fuelwood is non-sustainable. We need to persist until the knowledge we have spreads and becomes common knowledge worldwide.

For questions or comments contact Dr. Robert Metcalf at rmetcalf@csus.edu.

Dr. Robert Metcalf
1324 43rd St.
Sacramento, California 95819 USA.

You can hear some of Dr. Metcalf's speeches here.

IDEXX Laboratories, Inc. makes the Colilert kit and is located at this address:

IDEXX Laboratories, Inc.
One IDEXX Drive
Westbrook, ME 04092
USA

Voice: (800) 321-0207 or (207) 856-0496
Fax: (207) 856-0630

Here is their Web page on the Colilert System.
Here is a large list of international contacts for obtaining and using this system.

See also the Solar Puddle Pasteurizer.

Editor's Note: Testing Water in Developing Countries

The Colilert system makes it possible to test water without the need for a laboratory. IDEXX Laboratories, the manufacturer, recommends that you use five test tubes for each sample. Bob Metcalf explains that five tubes would comprise 50 ml, which is the minimum sample size permitted by US law. This is an unrealistically high standard by which to judge the water in developing countries where you are examining water that is already being drunk, in spite of the fact that it may be making people sick. By using a single test tube (10 ml) there is a very small chance that your sample missed the small number of bacteria that might have been present.

IDEXX Laboratories will also tell you that you need an incubator to achieve valid results. Again, Bob Metcalf tells us that all that is needed is to keep the tubes close to your body for 36 hours, since body temperature is the correct incubation temperature.

What you are actually measuring in the test is the presence of 1) coliform bacteria, and 2) E. coli, a type of coliform bacteria that is largely found in fecal matter. A positive test for coliform bacteria might be due to coliform bacteria that has washed off of plant leaves , and thus be fairly innocuous. A positive test for E. coli, however, would indicate that any bacteriological contamination was from a fecal source, which might also contain Giardia, cholera, or other serious infectious microbes.

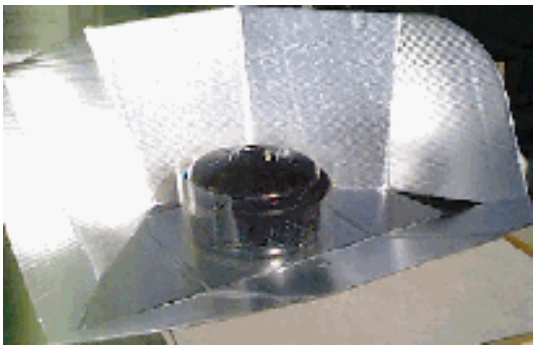
For questions or comments, contact
webmaster@solarcooking.org

http://solarcooking.org/metcalf.htm

The Solar Cooking Archive

Solar Cookers International Order Form

Print out this order form and mail or fax it to the address below. All prices in US dollars.

Description	Price	Quantity	Total
How to Make Solar Cookers (English, Spanish, or French)	$5		
Cooking with Sunshine, (cookbook)	$12		
Eleanor's Solar Cookbook	$12		
Solar Cooking Primer	$12		
Leaders Guide	$5		
Field Guide (for larger projects)	$5		
Trainers Manual (basics and how to teach them, language-free diagrams)	$10		
Black Pot	$12		
 The "Cookit"	$25		
The Sun Toy (like the Cookit, but crushable for travel)	$25		
The WAPI water pasteurization indicator (reusable, soy wax in plastic tube)	$6		
Teachers Kit, includes above items relevant to teaching	$45		

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Sacramento, California 95814
USA

Fax: (916) 455-4498

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Thank you.

Complete brochure available on request. Most orders sent within 3 weeks. Special attention paid to rush orders, if requested. SCI depends on members' donations to carry out programs to spread solar cooking worldwide--especially to countries where scarcity of cooking fuel is a rising cause of hunger. If you are interested in becoming a member, ask for a copy of our membership brochure.

The Solar Cooking Archive

Solar Cooking Plans

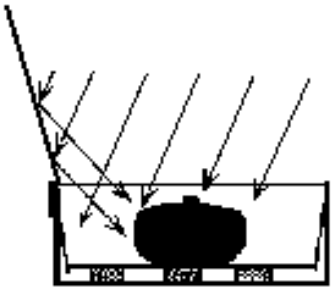
Box-Style Cookers

The "Minimum" Solar Box Cooker!
English, Arabic, Italian, Malagasy, Portuguese, Spanish

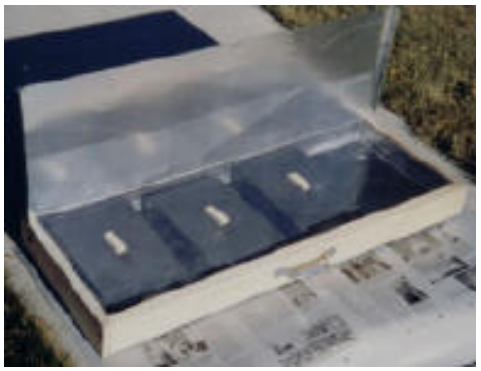
The "Easy Lid" Cooker
English, Catalan, Portuguese, Spanish

The Heaven's Flame Cooker

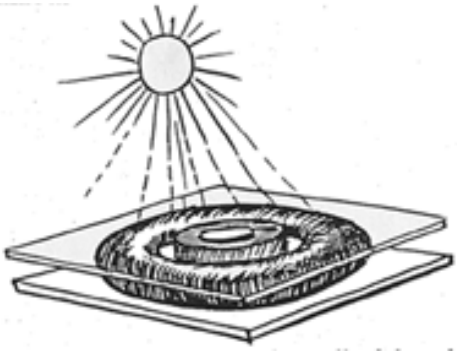
A Collapsible Solar Box Cooker
English, Portuguese, Spanish



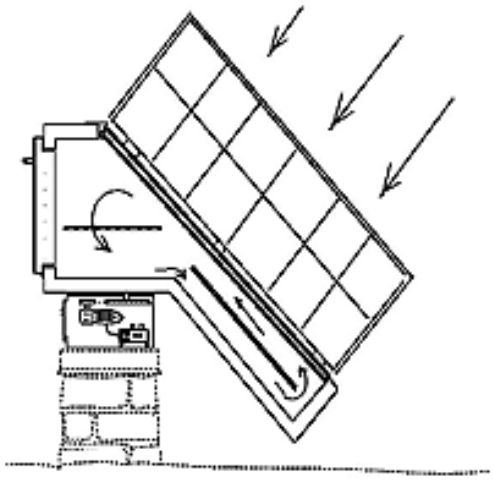
A Simple Solar Water Pasteurizer
English, Arabic, Portuguese, Spanish



The SunPan
English, Spanish

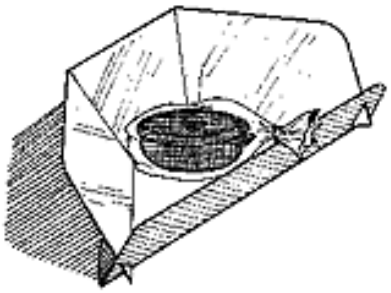


The Tire Cooker
English, Catalan, Italian, Portuguese, Spanish

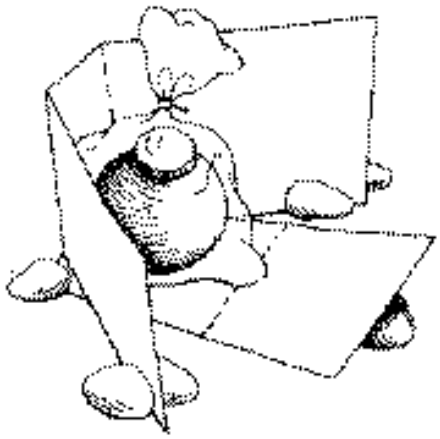


A Tracking Box Cooker (.pdf)

Panel Cookers



The "Cookit" Foldable Family Panel
English, French, German, Portuguese, Spanish



The Solar Panel Cooker (SPC)
English, French, Portuguese

The Reflective Open Box Cooker
English, Portuguese, Spanish

The Solar Funnel Cooker
English, Portuguese NEW!, Spanish

Dual-Setting Panel Cooker (DSPC)
English, Portuguese, Spanish

Mini Panel Cooker
English, Japanese

Windshield Shade Solar Funnel Cooker
English. Hebrew, Portuguese NEW!

The Parvati Solar Cooker
English, Spanish

The Nelpa Solar Panel Cooker
English

The Pentagon Star Cooker
English, Portuguese

Parvati Solar Cooker (Twelve Sided)
English, Spanish

Parabolic Cookers

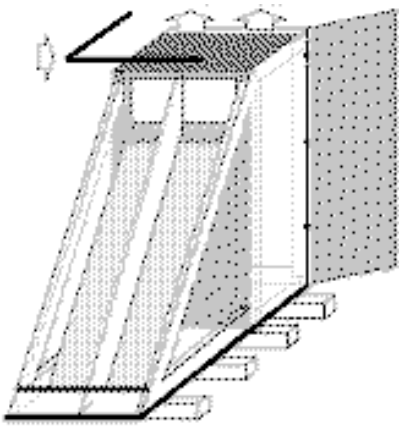
A cardboard parabolic cooker

A Fresnel parabolic cooker

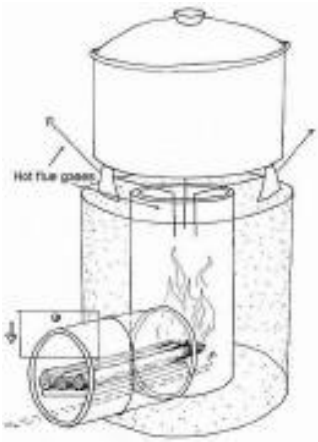
Double-Angled-Twelve-Sided (DATS) English, French, Portuguese, Spanish

A solar cooker mirror made of clay

Other



Solar Chimney Dehydrator



The Aprovecho Rocket Stove

Soda Bottle Pasteurizer

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The "Minimum" Solar Box Cooker

A great solar oven you can build quickly from two cardboard boxes

Experiments in Seattle and Arizona have proven that solar box cookers can be built more simply than even the simple method we have been using. These discoveries have paved the way for a simpler construction method that allows a cooker to be built in a few hours for very little money.

When we designed this cooker, we named it the "Minimum Solar Box Cooker" because, at the time, it represented the simplest design we could devise. What we didn't communicate with that name was that this is a full-power cooker that works very well, and is in no way "minimum" as far as capabilities.

What You Will Need

- Two cardboard boxes. We would suggest that you use an inner box that is at least 15" x 15" (38cm x 38cm), but bigger is better. The outer box should be larger all around, but it doesn't matter how much bigger, as long as there is a half inch (1.5cm) or more of an airspace between the two boxes. Also note that the distance between the two boxes does not have to be equal all the way around. Also, keep in mind that it is very easy to adjust the size of a cardboard box by cutting and gluing it.
- One sheet of cardboard to make the lid. This piece must be approximately 2" - 3" (4 - 8cm) larger all the way around than the top of the finished cooker.
- One small roll of aluminum foil.
- One can of flat-black spray paint (says on can "non-toxic when dry") or one small jar of black tempera paint. Some people have reported making their own paint out of soot mixed with wheat paste.
- At least 8 ounces of white glue or wheat paste.
- One Reynolds Oven Cooking Bag®. These are available in almost all supermarkets in the U.S. and they can be mail-ordered from Solar Cookers International. They are rated for 400° F (204.4° C) so they are perfect for solar cooking. They are not UV-resistant; thus they will become more brittle and opaque over time and may need to be replaced periodically. A sheet of glass can also be used, but this is more expensive and fragile, and doesn't offer that

much better cooking except on windy days.

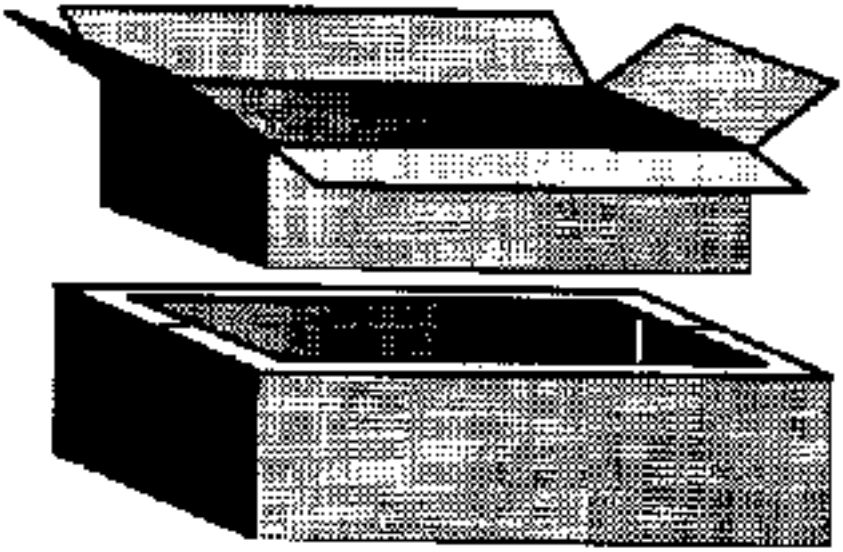

Figure 1

Building the Base

Fold the top flaps closed on the outer box and set the inner box on top and trace a line around it onto the top of the outer box, Remove the inner box and cut along this line to form a hole in the top of the outer box (Figure 1).

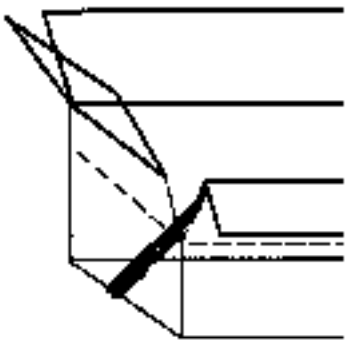

Figure 2

Decide how deep you want your oven to be (about 1" or 2.5cm bigger than your largest pot and at least 1" shorter than the outer box) and slit the corners of the inner box with a knife down to that height. Fold each side down forming extended flaps (Figure 2). Folding is smoother if you first draw a firm line from the end of one cut to the other where the folds are to go.

Glue aluminum foil to the inside of both boxes and also to the inside of the remaining top flaps of the outer box. Don't waste your time being neat on the outer box, since it will never be seen, nor will it experience any wear. The inner box will be visible even after assembly, so if it matters to you, you might want to take more time here. Glue the top flaps closed on the outer box.

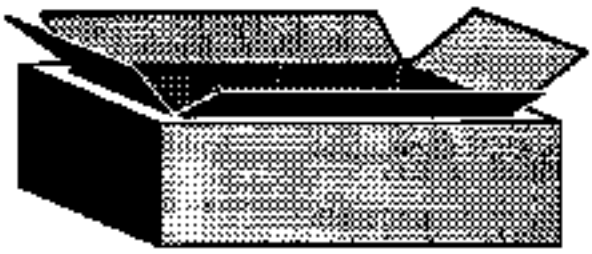

Figure 3

Place some wads of crumpled newspaper into the outer box so that when you set the inner box down inside the hole in the outer box, the flaps on the inner box just touch the top of the outer box (Figure 3). Glue these flaps onto the top of the outer box. Trim the excess flap length to be even with the perimeter of the outer box.

Finally, to make the drip pan, cut a piece of cardboard, the same size as the bottom of the interior of the oven and apply foil to one side. Paint this foiled side black and allow it to dry. Put this in the oven (black side up) and place your pots on it when cooking. The base is now finished.

Building the Removable Lid

Take the large sheet of cardboard

and lay it on top of the base. Trace its outline and then cut and fold down the edges to form a lip of about 3" (7.5cm). Fold the corner flaps around and glue to the side lid flaps. (Figure 4). Orient the corrugations so that they go from left to right as you face the oven so that later the prop may be inserted into the corrugations (Figure 6). One trick you can use to make the lid fit well is to lay the pencil or pen against the side of the box when marking (Figure 5). Don't glue this lid to the box; you'll need to remove it to move pots in and out of the oven.

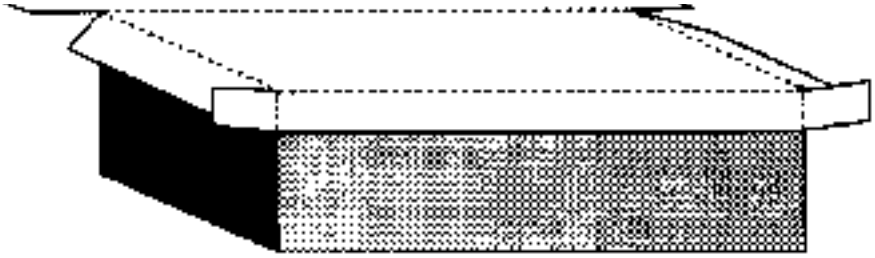

Figure 4

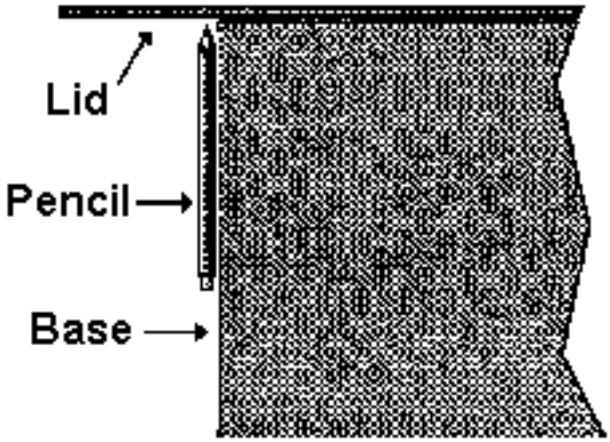

Figure 5

To make the reflector flap, draw a line on the lid, forming a rectangle the same size as the oven opening. Cut around three sides and fold the resulting flap up forming the reflector (Figure 6). Foil this flap on the inside.

To make a prop bend a 12" (30cm) piece of hanger wire as indicated in Figure 6. This can then be inserted into the corrugations as shown.

Next, turn the lid upside-down and glue the oven bag (or other glazing material) in place. We have had great success using the turkey size oven bag (19" x 23 1/2", 47.5cm x 58.5cm) applied as is, i.e., without opening it up. This makes a double layer of plastic. The two layers tend to separate from each other to form an airspace as the oven cooks. When using this method, it is important to also glue the bag closed on its open end. This stops water vapor from entering the bag and condensing. Alternately you can cut any size oven bag open to form a flat sheet large enough to cover the oven opening.

Improving Efficiency

The oven you have built should cook fine during most of the solar season. If you would like to improve the efficiency to be able to cook on more marginal days, you can modify your oven in any or all of the following ways:

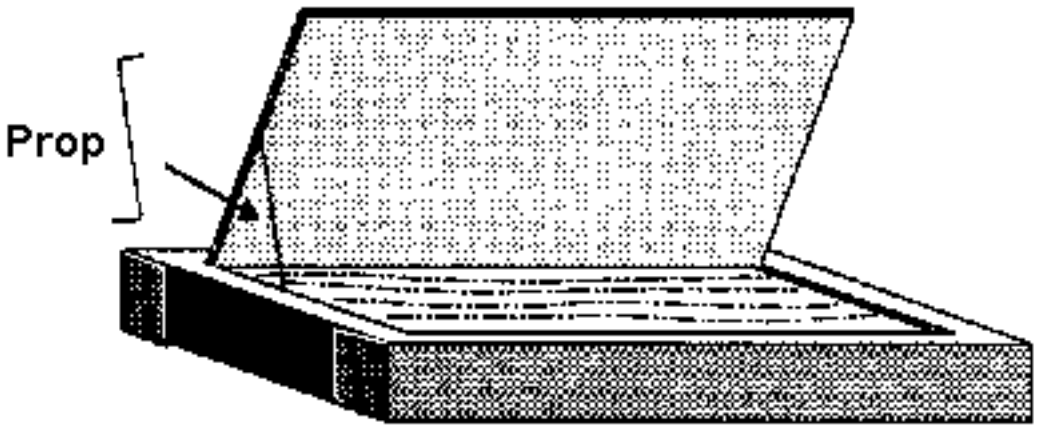

Figure 6

- Make pieces of
  foiled cardboard the same size as the oven sides and place these in the wall spaces.
- Make a new reflector the size of the entire lid (see photo).
- Make the drip pan using sheet metal, such as aluminum flashing. Paint this black and elevate this off the bottom of the oven slightly with small cardboard strips.

Here are some good documents to read to learn more about solar cooking:

- Solar Cooking Frequently-Asked Questions (FAQ)
- Developing an Intuitive Feel for the Dynamics of Solar Cooking
- Principles of Solar Box Cooker Design
- Solar Cooking Hints
- Three Reasons Solar Cooking Deserves New Attention
- Solar Cookbooks

For more information contact:

Solar Cookers International
1919 21st Street, #101
Sacramento, California 95814
info@solarcookers.org

This document is published on Solar Cooking Archive at http://solarcooking.org/minimum.htm

The "Easy Lid" Cooker

Aquí en Español

Designed by Chao Tan and Tom Sponheim

Although designs for cardboard cookers have gotten simpler, fitting a lid can still be difficult and time consuming. In this version, a lid is formed automatically from the outer box.

Making the Base

1. Take a large box and cut it in half as shown in Figure 1. Set one half aside to be used for the lid. The other half becomes the base.

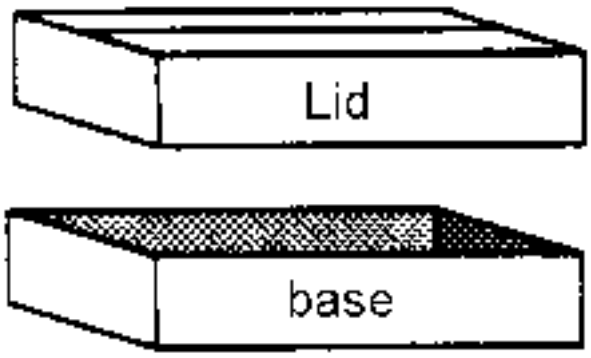

Figure 1

2. Fold an extra cardboard piece so that it forms a liner around the inside of the base (see Figure 2).

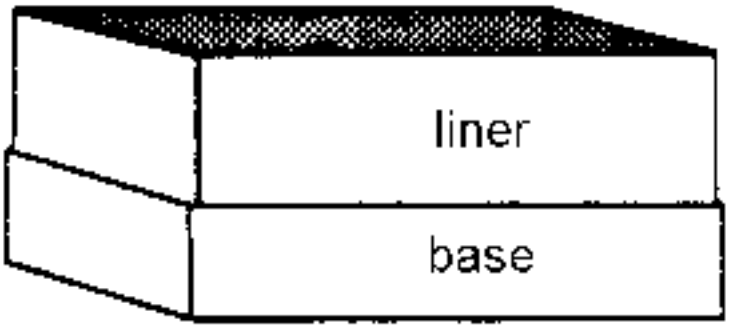

Figure 2

3. Use the lid piece as shown in Figure 3 to mark a line around the liner.

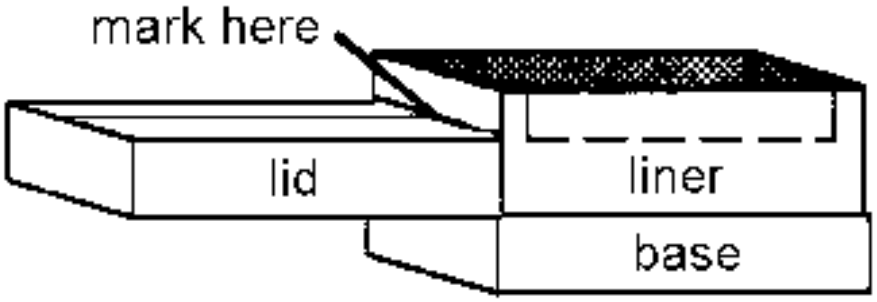

Figure 3

4. Cut along this line, leaving the four tabs as shown in Figure 4.

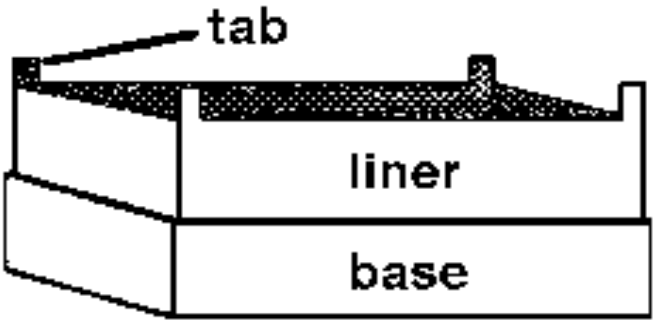

Figure 4

5. Glue aluminum foil to the inside of the liner and to the bottom of the outer box inside.
6. Set a smaller (inner) box into the opening formed by the liner until the flaps of the smaller box are horizontal and flush with the top of the liner (see Figure 5). Place some wads of newspaper between the two boxes for support.

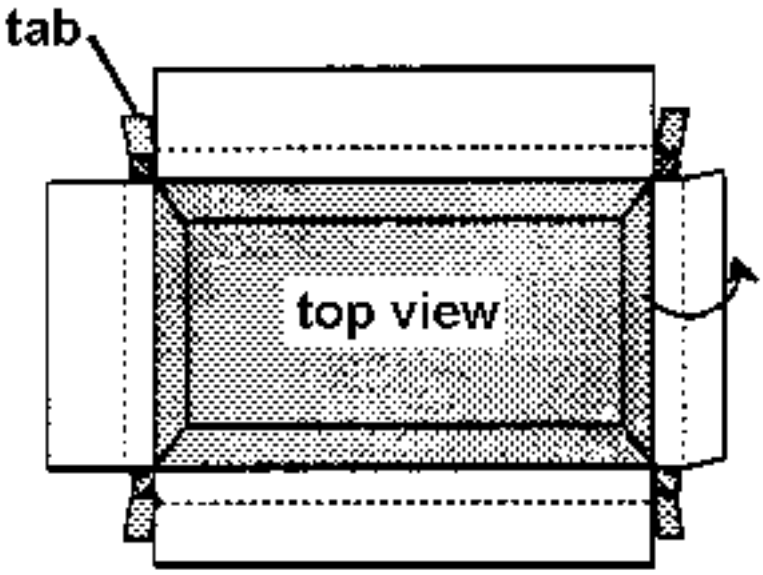

Figure 5

7. Mark the underside of the flaps of the smaller box using the liner as a guide.
8. Fold these flaps down to fit down around the top of the liner and tuck them into the space

between the base and the liner (see Figure 6).

9. Fold the tabs over and tuck them under the flaps of the inner box so that they obstruct the holes in the four corners (see Figure 6).

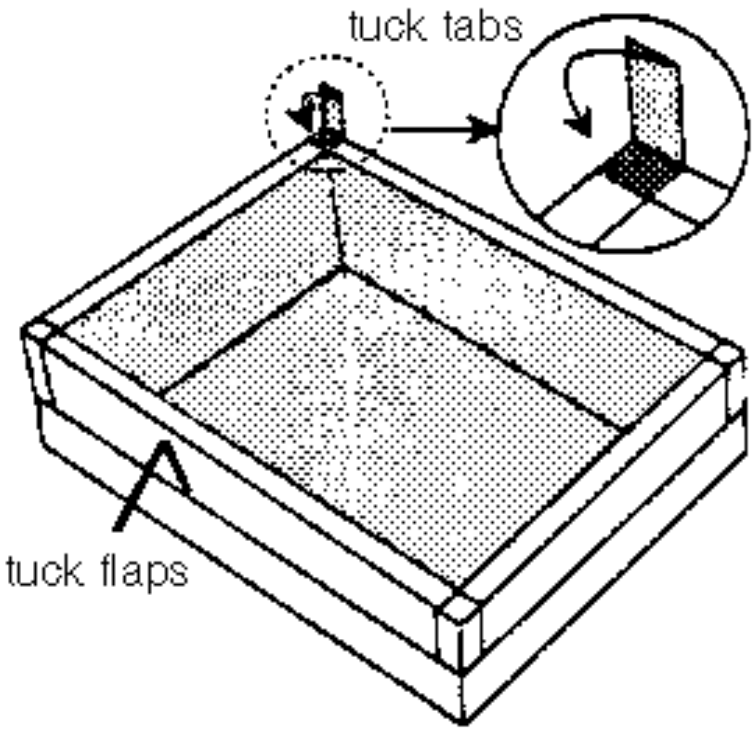

Figure 6

10. Now glue these pieces together in their present configuration.
11. As the glue is drying, line the inside of the inner box with aluminum foil.

Finishing the Lid

1. Measure the width of the walls of the base and use these measurements to calculate where to make the cuts that form the reflector in Figure 7. Only cut on three sides. The reflector is folded up using the fourth side as a hinge.
2. Glue plastic or glass in place on the underside of the lid. If you are using glass, sandwich the glass using extra strips of cardboard. Allow to dry.

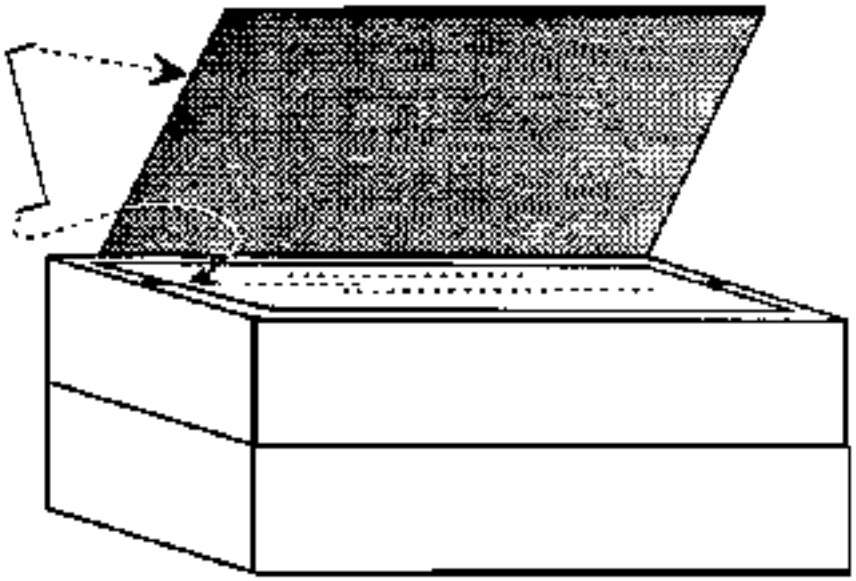

Figure 7

3. Bend the ends of the wire as shown in Figure 7 and insert these into the corrugations on the lid and on the reflector to prop open the latter.
4. Paint the sheet metal (or cardboard) piece black and place it into the inside of the oven.

Improving Efficiency

1. Glue thin strips of cardboard underneath the sheet metal (or cardboard) piece to elevate it off of the bottom of the oven slightly.
2. Cut off the reflector and replace it with one that is as large as (or larger than) the entire lid. This reflects light into the oven more reliably.
3. Turn the oven over and open the bottom flaps. Place one foiled cardboard panel into each airspace to divide each into two spaces. The foiled side should face the center of the oven.

For more information contact:

Solar Cookers International
1919 21st St., Suite 101
Sacramento, CA 95814 USA

or email: info@solarcookers.org

Principles of Solar Box Cooker Design

By Mark Aalfs, Solar Cookers International
e-mail: aalfs@yahoo.com

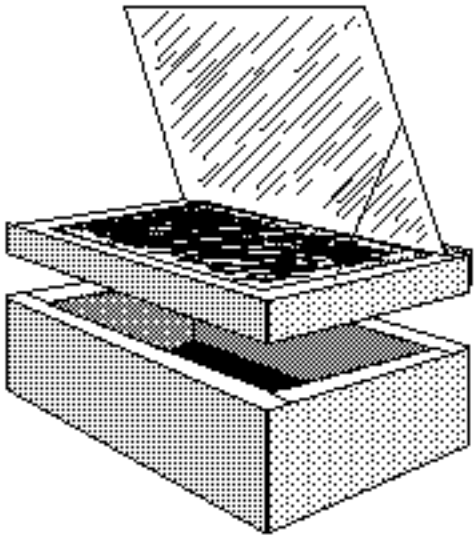

Figure 1. Solar box cooker with cover, window, and reflector

The purpose of this paper is to summarize the basic principles that are used in the design of solar box cookers.

People use solar cookers primarily to cook food and pasteurize water, although additional uses are continually being developed. Numerous factors including access to materials, availability of traditional cooking fuels, climate, food preferences, cultural factors, and technical capabilities, affect people's approach to solar cooking.

With an understanding of basic principles of solar energy and access to simple materials such as cardboard, aluminum foil, and glass, one can build an effective solar cooking device. This paper outlines the basic principles of solar box cooker design and identifies a broad range of potentially useful construction materials.

These principles are presented in general terms so that they are applicable to a wide variety of design problems. Whether the need is to cook food, pasteurize water, or dry fish or grain; the basic principles of solar, heat transfer, and materials apply. We look forward to the application of a wide variety of materials and techniques as people make direct use of the sun's energy.

The following are the general concepts relevant to the design or modification of a solar box cooker:

Heat Principles
Materials Requirements
Design and Proportion
Solar Box Cooker Operation
Cultural Factors
Back to the top

HEAT PRINCIPLES

The basic purpose of a solar box cooker is to heat things up - cook food, purify water, and sterilize instruments - to mention a few.

A solar box cooks because the interior of the box is heated by the energy of the sun. Sunlight, both

direct and reflected, enters the solar box through the glass or plastic top. It turns to heat energy when it is absorbed by the dark absorber plate and cooking pots. This heat input causes the temperature inside of the solar box cooker to rise until the heat loss of the cooker is equal to the solar heat gain. Temperatures sufficient for cooking food and pasteurizing water are easily achieved.

Given two boxes that have the same heat retention capabilities, the one that has more gain, from stronger sunlight or additional sunlight via a reflector, will be hotter inside.

Given two boxes that have equal heat gain, the one that has more heat retention capabilities - better insulated walls, bottom, and top - will reach a higher interior temperature.

The following heating principles will be considered first:

- **Heat gain**
- **Heat loss**
- **Heat storage**

Heat Principles: Heat gain, Heat loss, Heat storage | Materials Requirements
Design and Proportion | Solar Box Cooker Operation | Cultural Factors | To top

A. Heat gain

Greenhouse effect: This effect results in the heating of enclosed spaces into which the sun shines through a transparent material such as glass or plastic. Visible light easily passes through the glass and is absorbed and reflected by materials within the enclosed space.

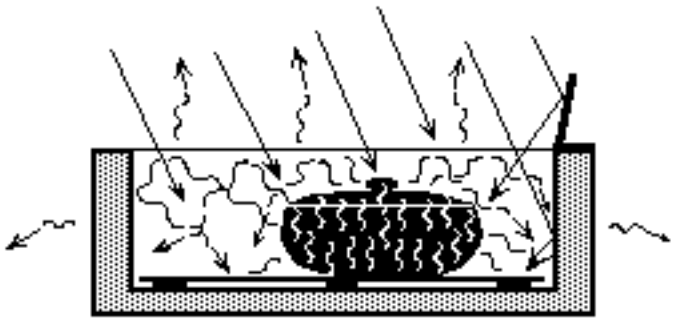

Figure 2. The greenhouse effect

The light energy that is absorbed by dark pots and the dark absorber plate underneath the pots is converted into longer wavelength heat energy and radiates from the interior materials. Most of this radiant energy, because it is of a longer wavelength, cannot pass back out through the glass and is therefore trapped within the enclosed space.

The reflected light is either absorbed by other materials within the space or, because it doesn't change wavelength, passes back out through the glass.

Critical to solar cooker performance, the heat that is collected by the dark metal absorber plate and pots is conducted through those materials to heat and cook the food.

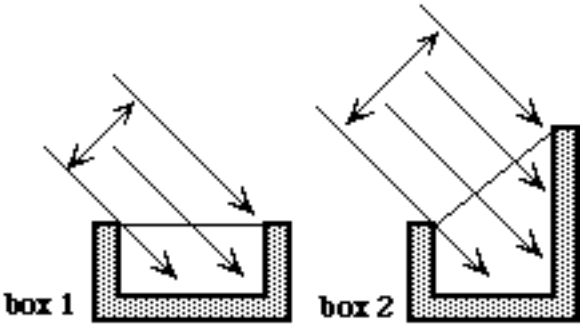

Figure 3. Glass orientation

Glass orientation: The more directly the glass faces the sun, the greater the solar heat gain. Although the glass is the same size on box 1 and box 2, more sun shines through the glass on box 2 because it faces the sun more directly. Note that box 2 also has more wall area through which to lose heat.

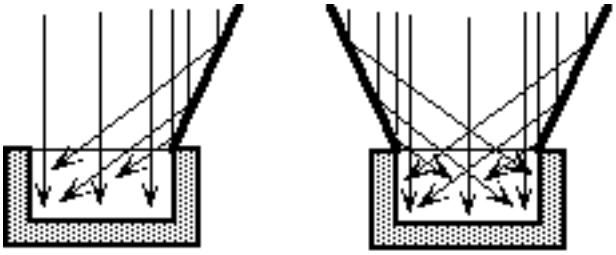

Figure 4. Reflectors for additional solar gain

Reflectors, additional gain: Single or multiple reflectors bounce additional sunlight through the glass and into the solar box. This additional input of solar energy results in higher cooker temperatures.

Heat Principles: Heat gain, Heat loss, Heat storage | Materials Requirements Design and Proportion | Solar Box Cooker Operation | Cultural Factors | To top

B. Heat loss

The Second Law of Thermodynamics states that heat always travels from hot to cold. Heat within a solar box cooker is lost in three fundamental ways: **Conduction, Radiation, and Convection**

Conduction:

The handle of a metal pan on a stove or fire becomes hot through the transfer of heat from the fire through the materials of the pan, to the materials of the handle. In the same way, heat within a solar box is lost when it travels through the molecules of tin foil, glass, cardboard, air, and insulation, to the air outside of the box.

Figure 5. Heat conducted through the pan to handle

The solar heated absorber plate conducts heat to the bottoms of the pots. To prevent loss of this heat via conduction through the bottom of the cooker, the absorber plate is raised from the bottom using small insulating spacers as in **figure 6.**

Radiation: Things that are warm or hot -- fires, stoves,

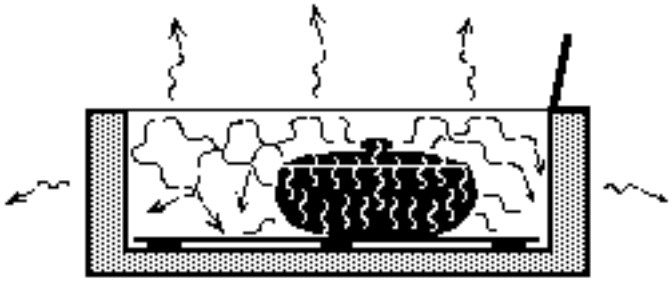

Figure 6. Heat radiates from warm cookware.

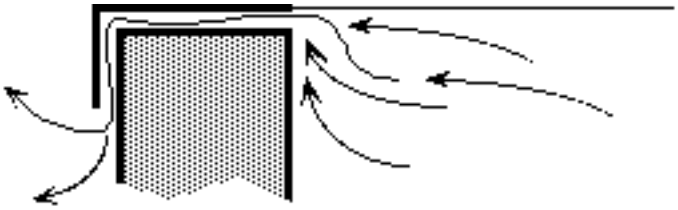

Figure 7. Heated air may escape through cracks.

or pots and food within a solar box cooker -- give off heat waves, or radiate heat to their surroundings. These heat waves are radiated from warm objects through air or space. Most of the radiant heat given off by the warm pots within a solar box is reflected from the foil and glass back to the pots and bottom tray. Although the transparent glazings do trap most of the radiant heat, some does escape directly through the glazing. Glass traps radiant heat better than most plastics.

Convection: Molecules of air move in and out of the box through cracks. They convect. Heated air molecules within a solar box escape, primarily through the cracks around the top lid, a side "oven door" opening, or construction imperfections. Cooler air from outside the box also enters through these openings.

C. Heat storage:

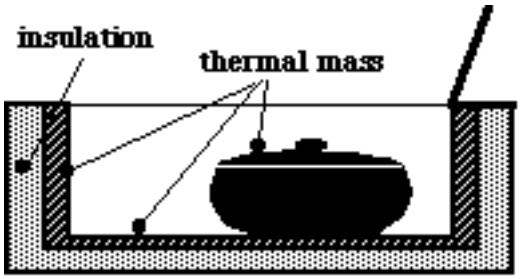

Figure 8. Thermal mass inside of the solar box.

As the density and weight of the materials within the insulated shell of a solar box cooker increase, the capacity of the box to hold heat increases. The interior of a box including heavy materials such as rocks, bricks, heavy pans, water, or heavy foods will take longer to heat up because of this additional heat storage capacity. The incoming energy is stored as heat in these heavy materials, slowing down the heating of the air in the box.

These dense materials, charged with heat, will radiate that heat within the box, keeping it warm for a longer period at the day's end.

Heat Principles: Heat gain, Heat loss, Heat storage | Materials Requirements
Design and Proportion | Solar Box Cooker Operation | Cultural Factors | To top

MATERIALS REQUIREMENTS

There are three types of materials that are typically used in the construction of solar box cookers. A property that must be considered in the selection of materials is moisture resistance.

A. Structural material
B. Insulation
C. Transparent material
D. Moisture resistance

A. Structural material

Structural materials are necessary so that the box will have and retain a given shape and form, and be durable over time.

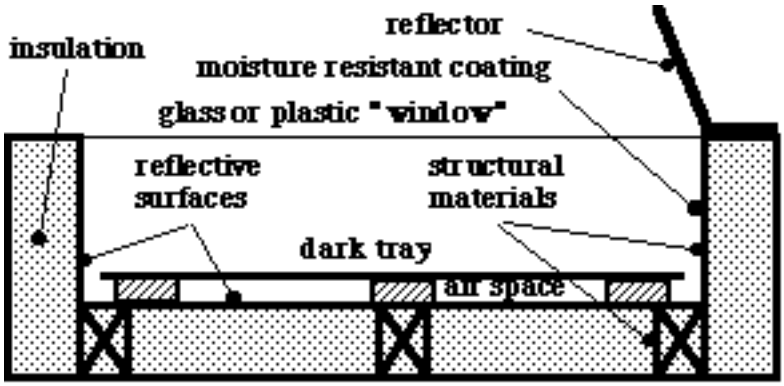

Figure 9: Materials: structural, insulation, transparent, and moisture resistant.

Structural materials include cardboard, wood, plywood, masonite, bamboo, metal, cement, bricks, stone, glass, fiberglass, woven reeds, rattan, plastic, papier mache, clay, rammed earth, metals, tree bark, cloth stiffened with glue or other material.

Many materials that perform well structurally are too dense to be good insulators. To provide both structural integrity and good insulation qualities, it is usually necessary to use separate structural and insulating materials.

B. Insulation

In order for the box to reach interior temperatures high enough for cooking, the walls and the bottom of the box must have good insulation (heat retention) value. Good insulating materials include: aluminum foil (radiant reflector), feathers (down feathers are best), spun fiberglass, rockwool, cellulose, rice hulls, wool, straw, and crumpled newspaper.1

When building a solar cooker, it is important that the insulation materials surround the interior cooking cavity of the solar box on all sides except for the glazed side -- usually the top. Insulating materials should be installed so that they allow minimal conduction of heat from the inner box structural materials to the outer box structural materials. The lower the box heat loss, the higher the cooking temperatures.

C. Transparent material

At least one surface of the box must be transparent and face the sun to provide for heating via the "greenhouse effect." The most common glazing materials are glass and high temperature plastics such as oven roasting bags. Double glazing using either glass or plastic affects both the heat gain and the heat loss. Depending on the material used, the solar transmittance - heat gain - may be

reduced by 5-15%. However, because the heat loss through the glass or plastic is cut in half, the overall solar box performance is increased.

D. Moisture resistance

Most foods that are cooked in a solar box cooker contain moisture. When water or food is heated in the solar box, a vapor pressure is created, driving the moisture from the inside to the outside of the box. There are several ways that this moisture can travel. It can escape directly through box gaps and cracks or be forced into the box walls and bottom if there is no moisture barrier. If a box is designed with high quality seals and moisture barriers, the water vapor may be retained inside the cooking chamber. In the design of most solar box cookers, it is important that the inner-most surface of the cooker be a good vapor barrier. This barrier will prevent water damage to the insulation and structural materials of the cooker by slowing the migration of water vapor into the walls and bottom of the cooker.

Heat Principles: Heat gain, Heat loss, Heat storage | Materials Requirements
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DESIGN, PROPORTION, and OPERATION

A. Box size

A solar box cooker should be sized in consideration of the following factors:

- The size should allow for the largest amount of food commonly cooked.
- If the box needs to be moved often, it should not be so large that this task is difficult.
- The box design must accommodate the cookware that is available or commonly used.

B. Solar collection area to box volume ratio

Everything else being equal, the greater the solar collection area of the box relative to the heat loss area of the box, the higher the cooking temperatures will be.

Given two boxes that have solar collection areas of equal size and proportion, the one that is of less depth will be hotter because it has less heat loss area.

C. Solar box cooker proportion

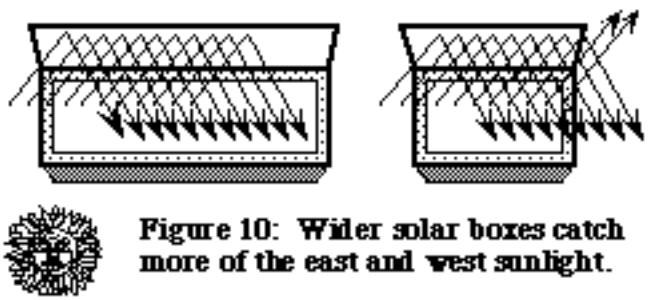

Figure 10: Wider solar boxes catch more of the east and west sunlight.

A solar box cooker facing the noon sun should be longer in the east/west dimension to make better use of the reflector over a cooking period of several hours. As the sun travels across the sky, this configuration results in a more consistent cooking temperature. With square cookers or ones having the longest dimension north/south, a greater percentage of the early morning and late afternoon sunlight is reflected from the reflector to the ground, missing the box collection area.

D. Reflector

One or more reflectors are employed to bounce additional light into the solar box in order to increase cooking temperatures. Although it is possible to solar cook without reflectors in equatorial when the sun is mostly overhead, reflectors increase cooking performance significantly in temperate regions of the world. See **Reflectors - figure 4**.

SOLAR BOX COOKER OPERATION

One of the beauties of solar box cookers is their ease of operation. For mid-day cooking at 20° N - 20° S latitude, solar box cookers with no reflector need little repositioning to face the sun as it moves across the mid-day sky. The box faces up and the sun is high in the sky for a good part of the day. Boxes with reflectors can be positioned toward the morning or afternoon sun to do the cooking at those times of day.

Solar box cookers used with reflectors in the temperate zones do operate at higher temperatures if the box is repositioned to face the sun every hour or two. This adjustment of position becomes less necessary as the east/west dimension of the box increases relative to the north/south dimension.

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Design and Proportion | Solar Box Cooker Operation | Cultural Factors | To top

CULTURAL FACTORS

In addition to the primarily technical aspects of solar box cooker design, factors including culture, appropriate technology, and aesthetics play a major role in the successful technology transfer of solar box cooking.

Through the centuries, the power of the sun has been tapped in numerous ways. With solar cooking, as with other endeavors, some design approaches work better than others. Technology that is designed to efficiently accomplish a given task while meeting certain energy use, environmental, social, cultural, and/or aesthetic standards, is often referred to as "appropriate technology."

Unfortunately, the field of solar cooking has its share of devices that fail these basic technical and social tests. For example, parabolic cookers can cook food, but when compared to the solar box approach, they are more difficult to build, require specialized materials and constant refocusing, may burn food, and are not likely to be accepted in most social and cultural contexts. In fact, because of the well publicized failures of these devices in several development projects in the '60s, many still believe that solar cooking is not feasible.

The better a given solar box design meets appropriate technology criteria, the more likely it is to be embraced by those using it. A very low-tech approach is to simply dig a shallow pit in the

ground, insulate the bottom with dried grass or leaves, insert the food or water in a dark container, and place glass over the top. On the high-tech end of the scale, the very same solar principles could be used with standard building and insulating materials and high performance low-emmissivity glazing, to architecturally integrate a solar cooker into the south side of a contemporary kitchen. The solar oven door could be on the wall at a convenient height right next to the microwave.

Cardboard solar box cookers may be appropriate for many cultures because the materials are widely available and inexpensive. But disadvantages of cardboard include susceptibility to moisture damage and lack of durability compared to many other materials.

Aesthetics are usually important. Cultures having rounded forms as the norm may reject the entire solar cooking concept because the box is square. And certain social strata may reject cardboard as too "cheap" a material for their use.

It is important that the basic principles of solar design not be rejected because of the failures of a particular solar devices or technology transfer methodologies!

Certainly, one of the advantages of people designing their own solar box cookers is that they will apply the solar principles using their own materials and aesthetic sense. People that build their houses and furnishings out of wood or bamboo, are likely to include these materials in their cooker design. Surface decoration of solar boxes using various paints and textures also helps to integrate cookers into a given culture. There are many **forms** that can follow the solar **function**.

Location of the solar cooker and the cooking activity, permanence or portability of the solar cooker, time of day when it is used, and importance of cooking as a social activity are other varying factors that will affect the design of solar cookers.

The solar box cooker project in the Indian Himalaya, sponsored by the Indo-German Dhauladhar Project, is a successful application of the principles of solar box cooking to the needs of a particular culture. The non portable cooker is built of earth and brick and is double glazed with glass. An inner tin oven is fabricated from used ghee or oil containers. Husk from a rice sheller provides insulation around the tin oven.

> "Materials are derived from the market economy (glass, black paint, nails, etc.), the local economy (labor, wood), and the non-monetary subsistence economy (mud bricks, bamboo, fabric). Using familiar materials and skills makes it easy to train builders and to help people maintain their cookers."2

The Dhauladhar Project participants, through the adaptation of solar cooking concepts to local needs and customs, demonstrated an effective technology transfer process.

Although it is somewhat beyond the scope of this discussion of design principles, other factors critical to the successful long-term implementation of solar cooking deserve note.

In order to successfully transfer solar cooking technology from one culture to another, a durable and long-lived bridge is critical. Individuals from both cultures form that bridge. People from the transferring culture must have a high degree of cultural sensitivity and make a significant time committment. Success is more likely if individuals from the implementing culture are leaders in their own communities. How well these individuals work together will play a large part in the success or failure of the process. Community is, by definition, a web of interconnected activities.

For solar cooking to become a part of local culture, it must be considered in the context of community activities such as local economics, work, healthcare, social activities, energy resources, deforestation, education, the technical infrastructure, and others.

Solar box cooking has already been practiced within a variety of cultures. But we've only scratched the surface. The potentially dramatic benefit of this resource in terms of world hunger, health, and deforestation has yet to be realized.

One of the primary purposes of Solar Box Cookers Northwest is to further the cause of solar cooking worldwide through information distribution and technology transfer. If you would like to work with us, we'd be happy to discuss our work and any of your ideas. We also like to see new designs and photos. Please contact us at the address on the first page of this paper.

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next up previous

Next: 1. General Remarks

Designing and Building Home Made Focusing Solar Cookers

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just like she/he wants.

I would appreciate, if the following web-address, my name and my e-mail address would be mentioned as references. Comments would be especially appreciated to the e-mail address.

This manual is available at: http://www.cc.jyu.fi/~hvirtane/cooker/

street address:

Hannu Virtanen;

Lievestuoreen asema;

FIN-41400 Lievestuore; Finland

email: hvirtane@cc.jyu.fi

Here are the main documents of the original 'Technology For Life' Nepal project, which has led to this 'home made cookers' initiation.

There is available a complete plan for a small cooker here.

There are available pictures about building cookers in Nepal here.

- 1. General Remarks
- 2. The General Principle: How Does it Work?
- 3. The Basic Parts and Materials of the Cooker
- 4. The Mirror Base in Detail
  - 4.1. The Mirror Base: the shape of the mirror
    - 1) The following picture represents the curve for a parabola with F=50
    - 2) The shape for F=30 is as in the following graph:
    - 3) How to draw a parabolic curve without any knowledge of Mathematics:
  - 4.2. Mirror base materials and construction ideas:

- 4.3. Paper mass, clay or concrete construction:
  - a1) Making the mold inside the ground
  - a2) Making the mold on the ground
- 4.4. Other methods how to make the mirror base:
- 4.5. Some further notes concerning the shape

- 5. Hanging the mirror
- 6. The mirror holdig system
- 7. The turning table
- 8. The adjusting rope
- 9. The direction indicator
- 10. The reflective surface
  - The following picture will show in general the method how to make and fix the reflective pieces.
  - In many cases the reflective surface will be made of aluminium foil or of something rather similar.
  - You can use small mirror pieces as well.
- 11. The mirrorholder/potholder
- 12. The pots and the haybox
- About this document ...

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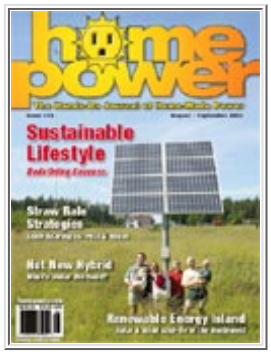
Issue #102 Contents



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Home Power magazine, the hands-on journal of home-made power, grew out of our passion for renewable energy (RE). We're concerned about a world that is increasingly polluted. We're concerned about the high energy use and waste of "developed" cultures. And we're concerned that people are dependent and unable to care for themselves when it comes to energy. Renewable energy gives people control over their energy future by using energy that is provided daily by nature. New to Home Power... click here to learn about us!

Feature Articles

Solar Cheese

The Vella Cheese factory has been soaking up the abundant California sunâ€”and solar energy rebates and tax credits. This familyowned and operated small business saves money on its monthly electricity bills with a 30 KW grid-intertied, solarelectric system. The factory combines Old World values and modern technology to produce its fine cheeses at one of Sonoma, Californiaâ€™s, oldest and most historic businesses.
Ignazio Vella understands that his success in making award-winning cheese lies in his attention to each dayâ€™s production and the quality.... more

Hybrid Vehicle

A redesigned mid-sized envirocar is on the blockâ€”the 2004 Toyota Prius. The Prius has become very popular with people concerned with the environment. This is due in some part to the environmental impact of emissions, increasing fuel prices, potential gas shortages, and our dependence on foreign sources of fuel. The engineering crowd likes it for its design and technical excellence, and the wealthy and famous have embraced the Toyota Prius as well.... more

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RE Tips

To increase your PV array's seasonal output, you can adjust its tilt angle several times a year.

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"The sun, with all those planets revolving around it and dependent on it, can still ripen a bunch of grapes as if it had nothing else in the universe to do."

Galileo Galilei

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Welcome to

SOLAR COOKING

You can cook almost anything with the sun and a "low tech" solar oven!

Homemade solar box cooker (you can make one of these out of plywood or even cardboard) These cookers can reach temperatures in excess of 300 f! This solar oven is constructed of a plywood box within a larger, outer plywood box. The space between the boxes is insulated with approx. 2" of "Perlite", the soil amendment gardeners use, although most people use regular fiberglass insulating material. (this was an experimental material that does work very well) The reflector is an ordinary glass mirror, however, aluminum foil or reflective mylar can be used just as effectively. Covering the oven is 1/4" tempered glass. Lining the inner walls is aluminum roofing type flashing. On the floor of the oven are two flat black cookie sheets with black barbecue type grills that the pots rest upon. The idea is to get the sunlight concentrated into the oven by orienting the box and tilting the reflector. The oven will then quickly heat up because the sun's heat energy is trapped under the glass cover. The black surfaces and the dark food containers absorb the heat. I use black porcelain steel pots, oven cooking bags, and various containers that have been painted black with barbeque paint.

On this day the oven reached 250 F within 35 minutes. This is a perfect "slow cooking" temperature. HERE IS A MEXICAN STYLE DINNER BEING PREPARED IN THE SOLAR OVEN

The SUN OVEN, a commercially made solar oven.

This concentrator type of oven gets hotter than the conventional box cooker because of the added reflectors. On this day I baked a perfect lasagne!

SOLAR COOKER PLANS (courtesy Solar Cooking Archive)

Books about Solar Cooking

Here are some other solar cookers that I built using household materials.

Here you see (left to right) baked brownie muffins, a ham baking, a tri-tip cooking.

I have cooked many kinds of foods using solar ovens. You just put your food into a pot, aim the box at the sun, and you are all set for solar cooking with the free energy of the sun! The oven will heat up and slowly cook your meal during the sunny day. (like a crock pot does) This is great during the summer because you won't heat up your house, and, of course, there is no fuel that is spent! Here in California, where I live, I have cooked a beef roast on the shortest day of the year where the outside air temp was only 40F. The air temperature is not important. It is the sunlight that is concentrated into the oven that produces the heat. An average temperature of about 250 degrees F is easily achieved! You can cook rice, beans, bake bread, cook soups, steam vegetables, almost any recipe can be used. If the recipe calls for higher temperatures you just increase the cooking time. What a great camping tool this is, too! Imagine returning from a day of hiking, or fishing to find your dinner completely cooked, hot, and ready to eat. You can't beat this "low tech" way of cooking.

SOLAR COOKING PAGE 2

RECIPES PAGE

LINKS

e-mail: Doug Edwards

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Last updated by Doug Edwards on 6/27/04

Take a look around!

LINKS "LOW TECH" LINKS "LOW TECH" LINKS

Here are some links related to "Low Tech" living/ solar cooking- check them out!

Solar Cooking Archive
Lot's of solar cooking information-plans, organizations

SunOven
Manufacturer's web site.

Emergency Food Storage and Bread Mixes at Prepared Pantry
Providing great bakery products for your family - to be used now and in an emergency.

Crock Pot Recipes
Part of a huge site- this section is crockpot recipes that can be applied directly to solar cooking.

---

back to the SOLAR COOKING PAGE

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e-mail: drduggee

Last updated by Doug Edwards on 6/27/2004

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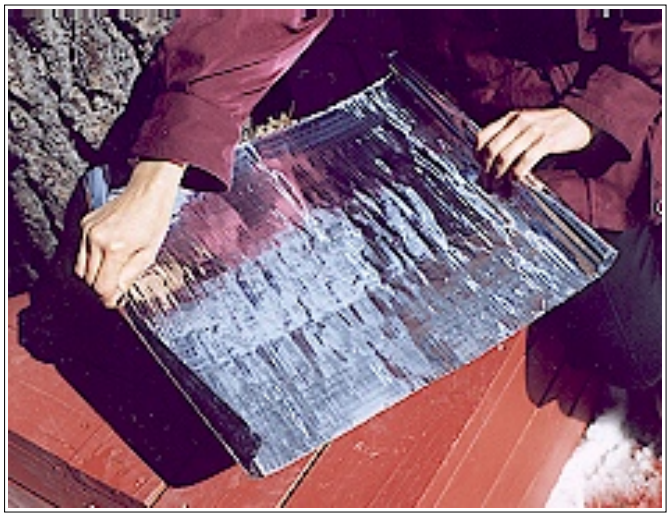

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We're finished testing our hottest, newest product, SolaReflex reflective panels with a bonded, patented SolaReflex metallic surface and an invisible protective top coating for better scratch and salt air resistance, with a minimum 7-8 year life. The ABS panels come with two different sides, diffused and near-mirror surfaces. The smoother polycarbonate panels have two mirror surfaces. Our SolaReflex 900 degree Parabolic cookers are over 300 degrees hotter than the 600 because of this patented super reflective surface!

Make your own solar cooking or daylighting reflector panel for only $18 for each standard size 2' x 4' sheet with the toughest, best reflecting material available-- ClearDome SolaReflex Foil. It's the best low cost reflector material available for daylighting purposes to add more sunlight into a building.

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Click for prices, to purchase, and to view other products.

It is so effective, this same type of material protects the astronauts and their equipment in outer space.

Our search for the absolute best solar reflecting material available for reflecting solar and radiant heat energy has ended. You can now benefit from over 50 years of private and government research, and NASA's continuing use in the space program to protect the astronauts in space.

Their space suits and spacecraft have depended on this same type of triple-laminated, tear-resistant metallic fabric to protect their lives. Intense, unfiltered solar energy is reflected away, and their body heat is radiated back inside. This near-perfect radiant barrier works as well in outer space as it does on earth--for generating heat as a solar reflector.

In numerous heating tests using our new SolarReflex 600 Parabolic cooking reflector, shown below (also visible on our homepage), two quarts of food was cooked in 50 minutes on a sunny 62 F degree day with no wind. Temperatures will reach over 600 degrees F in less than one minute when focused on our Blackflex solar absorption foil, as shown in the photo at right.

A piece of Blackflex has been positioned inside a clear glass and the infrared thermometer is focused on the hot spot created by our SolaReflex 600 parabolic reflector. A small piece of SolaReflex protects the top of the thermometer to prevent the plastic from melting. This 637 degree F temperature was recorded at 5 PM in the late afternoon on a 65 degree F day in spring.

SolaReflex is an upgraded and improved reflective material formally known as SolarFlex. SolaReflex is lighter, stronger and thinner so it's easier to use with less bulk, but with the same high level of 97.4% reflection and no extra cost.

SolarReflex is a diffused, but highly reflective material rated at 97.4% reflectivity and .03 emmisivity that can be applied to any flat, parabolic or concentrator type solar reflector form. It will withstand severe weather and temperatures from -60 to 400 degrees F. AT slightly over 4 mills thick, it is very difficult to tear by hand but easy to cut with scissors. And it can also be used as reflectors outside windows to brighten dark rooms and send solar energy (light and heat) back inside. Or, it will reflect nearly all solar energy away from structures when mounted on a flat surface to keep the interior much cooler. It is now being tested in India by the world's largest solar cooker manufacturer and is scheduled to be a integral part of their new parabolic solar cookers--the main reflective surface.

BlackFlex foil now available for superior heat absorption

Use SolaReflex with our thick and durable ClearDome BlackFlex anodized heat absorbing aluminum foil in your own design solar heating device or for any solar heat absorption application. We use it on our exterior forced air heaters because it's an excellent and long-lasting heat absorber material. It can also be used in solar box ovens or for reading solar generated temperatures. It's permanently colored black, and not painted, because it's anodized black on both sides. It's easy to form and inexpensive and has no gass-off or toxic fumes. BlackFlex is now available to order on our Amazon order page from the link below, and costs the same as SolaReflex in 2' X 4' sheets, $18 plus shipping and handling. Larger discount quantities are also available. Email for questions

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Blackflex heat absorption foil

Here's why SolaReflex is superior for solar cooking and radiant heat deflection use:

- **Outperforms every other type of solar heating reflector by 15-20%, including aluminum foil, Mylar, glass mirrors and most metals, for hotter, faster cooking and heating!**
- **Reflects 97.4% of visible and invisible solar and radiant heat energy for the brightest, hottest reflection**
- **Will withstand radiant temperatures to 400 degrees F, and below –60 degrees F.**
- **Safe and non-gassing at all temperatures**
- **Easy to glue, tape or staple over wood, paper, plastic, and metal frames or boxes. Make our parabolic or your own design reflector**
- **Very lightweight, waterproof, and is very difficult to tear by hand**
- **Easy to cut with sharp scissors or knife, but hard to puncture**
- **Can be re-formed many times with minimal wear**
- **Excellent as a light reflector indoors or outdoors for daylighting purposes or movie production**

Cleardome SolaReflex can only be purchased from us on the Internet and cannot be purchased in retail stores.

SolaReflex costs only $18 per standard 2' x 4' piece. Discounted bulk orders are also available on our Amazon order page. It can either be purchased through Amazon.com by clicking here or from the Amazon box above. You can also purchase directly from ClearDome Solar in the U.S.A., by sending your email request to: solarflex@cleardomesolar.com

The standard sheets are rolled into a three inch cardboard shipping tube, and weigh about eight ounces. Add $7 for up to four large sheets for shipping and handling in the U.S.A. International shipping is about $12. California residents must add 7.75% sales tax. Discount bulk ordering is now available on our Amazon order page.

In the photo on the left, SolaReflex is laminated to our hot new lightweight (8.5 pounds) SolaReflex 600 parabolic cooker. The sturdy dish is made of unbreakable, custom formed ABS plastic, also available on our Amazon order page. Cooking times are reduced to 45-70 minutes on a clear sunny day. For it's 24' x 26" size, it is the hottest solar cooking reflector made, because of the unique offset design of the dish, and the excellect reflective qualities of SolaReflex. The parabolic dish blanks are also available to purchase without SolaReflex laminated to the surface.

Use your own black pots and pans by themselves, or surrounded with our ClearDome Box oven or clear plastic

bags prevent heat loss in wind and for higher heating levels. For more information about this or any of our other innovative ClearDome Solar heating products including our solar forced air home heaters or thermal heating or barrier fabrics, please email Deris at: solareflex@cleardomesolar.com and visit our homepage at: www.cleardomesolar.com.

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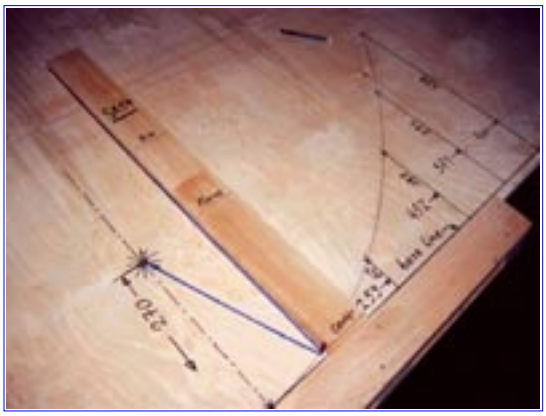
Parabola Design Wood Model

For the AMSI Solar cooker a simple wood model is used as a tool to assure the exact parabolic shape of the mirror. Precision is very important to get a small focal sun-spot and a high cooking temperature. With an off shape mirror the focal concentration becomes spread and eventually uneven distributed resulting in a cooker which heats up very quickly but does not reach higher temperatures than e.g. 95°C.

To design a parabola I recommend a very simple drawing tool which is able to construct any parabolic curve with ease:

Drawing Tool (click on the pictures to enlarge them)

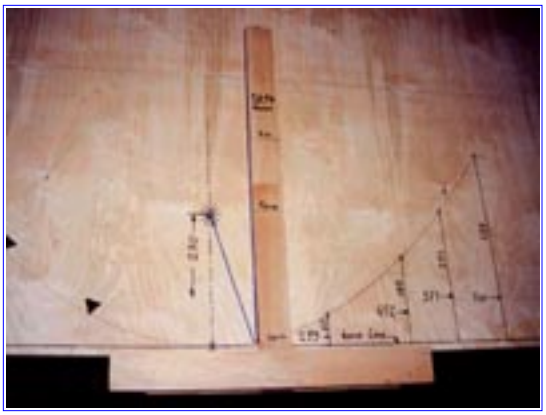
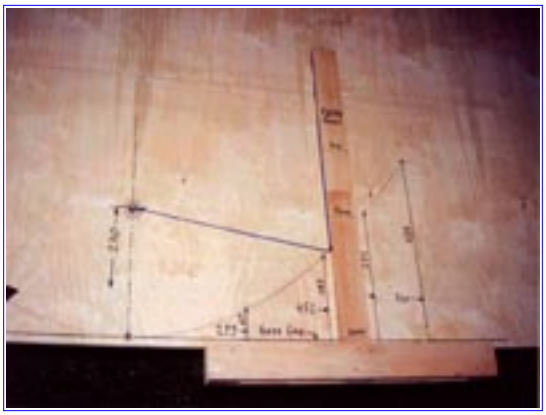
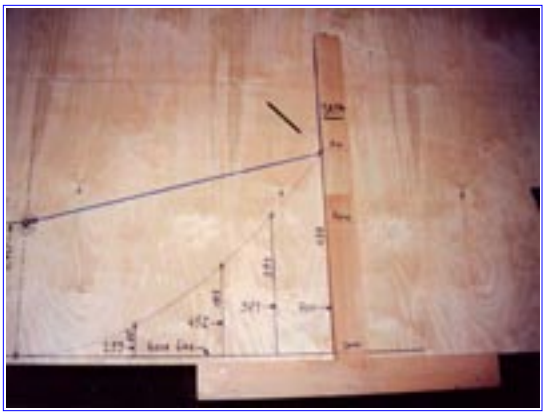
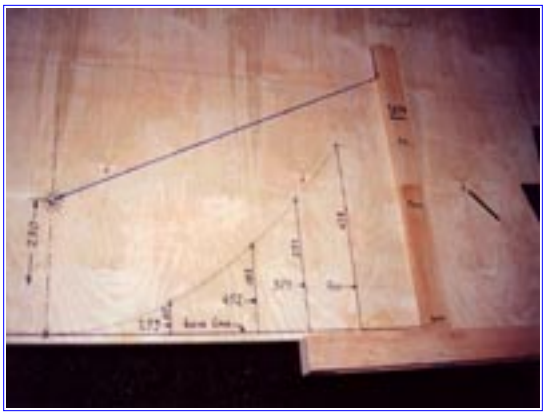


Usage of the Tool

it is a right angle ruler made of wood which can be used for many other purposes as well. At the top of the T-shaped device a string of variable length can be fixed. The string should be made from non elastic material like nylon which does not expand when stressed. The free end of the string holds a little ring or washer.
When put on a table or platewood board the lower horizontal part is pressed against the edge of the table so that the vertical part is always in a right angle to the edge while the tool may slide along the edge line.

Let's take a platewood board with a straight edge at the base and let's press the T-shaped tool now on the platewood edge, so that the vertical part marks the axis of the parabola passing through the focal point. Mark the focal point with a nail or screw on this axis in a distance to the baseline (edge

of the board) equal to the focal distance of the parabola to be constructed.
Hook the string with the ring over the screw a the focal point and place the string along the tolls vertical edge down to the baseline around the tip of a pencil which will later draw the parabola and up along the same edge to the top of the T-tool. Fix the string at the top of the tool so that the string is stiff stretched in this shape. Now sliding the tool to the right and following with the pencils tip the vertical ruler at the T-tool while keeping the string stressed will draw a parabola with the focal distance equal to the distance between the focal point and the start point of the pencils tip. (see pictures below)

click on the pictures to enlarge them.

In this example the focal distance has been chosen to be 270 mm (which is the value for the AMSI cooker and the SK14 and K14 cooker of EG-SOLAR). The other measures marked on the board are not needed to draw the parabola curve, but give the positions of the cage rings for the SK14 cooker and thereby proof that this tool works perfect!

To make the string visible, a blue wool string is used and the pens tip is replaced by a red pin. To draw the curve the wool string should be replaced by something inextendable like a nylon string (e.g. 0,5 mm as used for sea fishing).

It is maybe interesting to mention that string in any drawing position represents as well a ray coming from the sun parallel to the parabola's axis, hitting the parabola mirror and being reflected to the focal point! (Nice! Isn't it?)

If you cut out two pieces of platewood as shown below and put them crosswise together the wood model is ready which can be used as kind of scaffolding and support for the mirror's cage during construction:

click on the picture to enlarge it

The positions where to place the rings are marked by little black triangles. A gap with the same width as the thickness of the plate is cut out along the parabolas axis from the bottom to the mid at one piece and from the top to the middle at the second piece so that the two pieces fit together in a stable position as shown above without glue (see construction manual section 2.2.2, Figure 3). The model can be taken apart again for storage without effort.

click on the pictures to enlarge them.

Now after making exact rings of sizes as described in the construction manual (section 2.3.3) they can be placed on the wood model and the connection bars can be bend in a way they touch all the rings without stress before fixing them with wire and welding the cage. The nice thing is that even if a ring is slightly larger or smaller the cage will be still perfectly parabolic.

Using a model with eight instead of four 'wings' may be used if the cage should be made from bamboo as a parabolic basket, if reinforcement bars for concrete are too expensive or not available.

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Table of Contents

This page provides some information about experiences on promoting the use of a simple parabolic solar cooker to save firewood in Ethiopia. During my two year stay in the town Arba Minch I tried hard to found a solar cooker workshop for a small local production of solar cookers and to teach women in the usage of these cooker type for the preparation of traditional food.

Anybody who is interested in the **Construction and Use of Parabolic Solar Cookers** is invited to share my experiences and get:

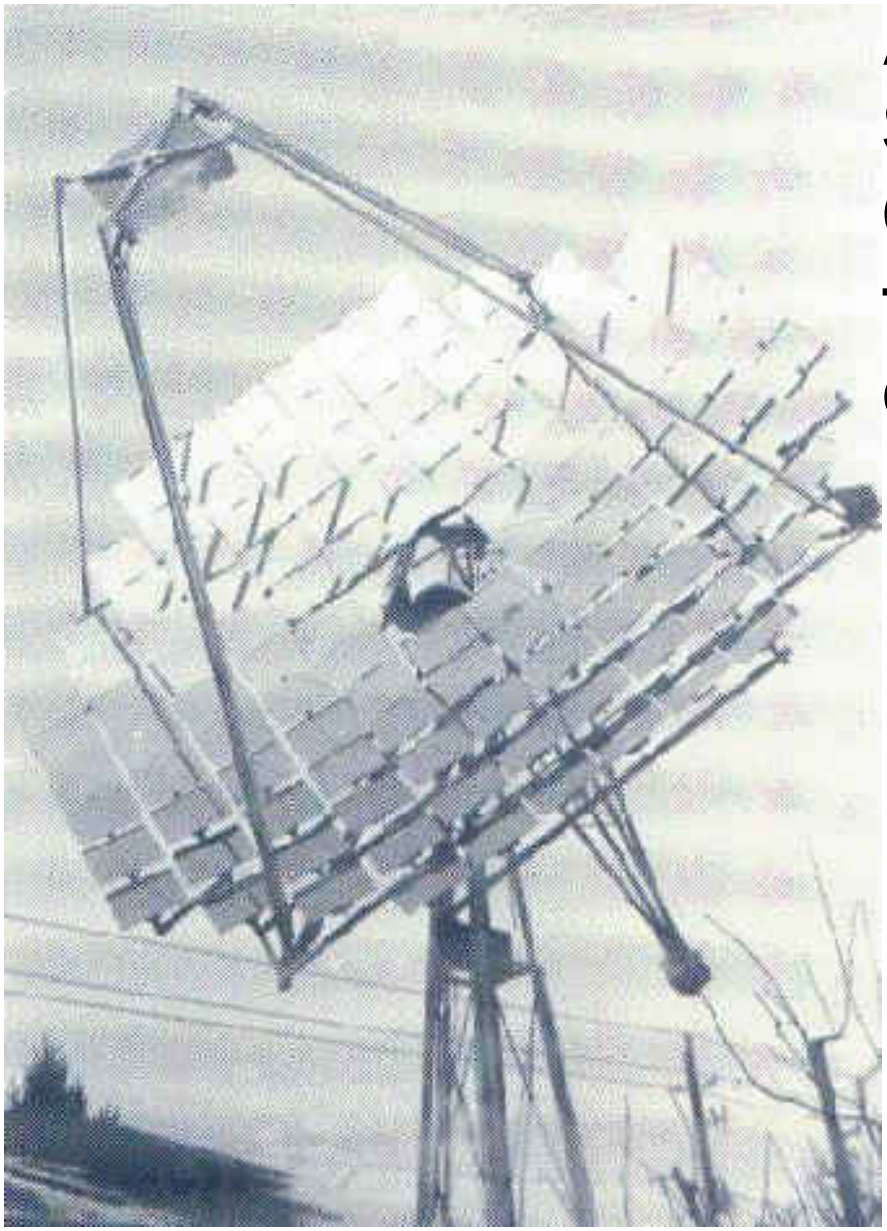
- Home
- General information's about the critical situation in Ethiopia
- The good Idea of Solar Cooking
- Information's about the AMSI project
- A description of the AMSI solar cooker
- Technical Data of the AMSI / EG-SOLAR solar cooker
- A booklet of LECTURE NOTES containing all these topics (pdf, 1MB)
- Detailed CONSTRUCTION PLANS and instructions to build the AMSI cooker (pdf, 3MB)
- Operation instructions and safety rules
- Cooking rules and procedures
- Information about EG-SOLAR, the parents of AMSI
- Pictures of the Project Implementation
- Other Solar Cooking projects in Ethiopia
- Interesting links to further information's on solar cooking
- 9. International Conference on Solar Cooking in Germany (Burghausen, 24./25.03.2001)
- Parabola Design and making the Wood-Model

The AMSI solar cooker project is based completely on my private initiative and money and not linked to any governmental or non governmental organization or support.

For discussion and support e-mail to the amsi-solar@gmx.net

This site was last updated on March 27, 2001.

11155



A Tracking Solar Concentrator for the home experimenter

It's been about twenty years since the USA experienced the big energy crunch and the resulting flurry of alternate energy schemes. Sadly, interest in solar, wind and other sources quickly faded as Americans came to suspect that the crunch was more created than real, and abundant petroleum was again available, but at greatly increased prices. Teton Engineering Inc developed a 20,000 Btu (6000 watt) solar concentrator designed specifically for the backyard mechanic to build using simple construction and basic materials. The design was marketed all around the world while interest was high, but eventually that interest faded away. We continue to receive requests for the manual but it has been withdrawn from the market long ago due to the ever increasing litigious atmosphere in the USA. Searching the internet, we find very little information to help the non professional or hobbyist solar energy experimenter so have decided to contribute the successful design to the public domain without an obligation to provide support or expect compensation. This information is offered for historical interest.

SAFETY WARNING

Working with solar concentrators is VERY DANGEROUS.

- Teton Engineering contributes this lore into the public domain freely and without obligation. You are cautioned that it is experimental, unsafe, and just plain dangerous. You or others may be blinded, maimed or killed while working with this device. We do not certify the design as safe or adequate in any way and must be considered as experimental. We advise you to not undertake construction of this device without professional guidance. It is not the intent of this manual to offer this guidance, but merely to document a successful design that operated continuously from 1980 to 1987.

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I am retired so I'm not available for consulatation, but I'd enjoy hearing from anyone that finds this historical information useful.

Wayne Roderick

email: tetonsl@ida.net

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Making and using a solar cooker

by Joe Radabaugh

Solar cooking is a delightful alternative to conventional cooking methods. The solar cookers available today really work and they deserve serious evaluation by a much larger audience. For 40 years, small groups of people have been using and refining some very good designs. But these designs have, for the most part, gone unnoticed even by those involved with alternative energy. With such a lack of support, you'd think they would have vanished from view long ago. But they haven't.

The people who have taken the time to integrate solar cooking into their lives find the motivation to keep refining the designs comes from the tools themselves: solar-cooked foods taste delicious and the ovens are fun and easy to use.

With the collectors back and the glass removed, it's easy to get at the cooked food.

My own involvement with solar cooking began in the mid-seventies. I found myself drawn to the alternative energy movement. Those were idealistic and innocent times, but they were also serious and important times.

The solar cooker aimed at the sun.

Started as a hobby

It was during those days that I saw my first solar cooker and began the hobby that led to the cooker described in this article. I started out building the most efficient styles I could come up with. Later, while keeping this efficiency, I strove to simplify the building process, the materials needed, and the actual use of the cooker. The cooker is now basically cardboard, aluminum foil, and glass. Yet, because of the design, it is remarkably efficient and durable.

It looks so simple now, but you should realize that this simplicity took years of effort and many accidental breakthroughs. The testing for this cooker is now complete.

A solar-cooked meal of rice, tomato sauce and winter squash.

What I have included here is a very good starter model that can lead you and your family to a lifetime of enjoyment without threatening your pocketbook. A solar cooker can easily be built for under $10.

Gathering materials

The first step involves a search for cardboard boxes in your local grocery and department stores. For the oven box, you are looking for two particular boxes. These can be rectangular (easier to find) or square (their collectors work better). The smaller of the two boxes becomes the inner box, so it defines the cooking area and the power of the cooker. For a medium size cooker, the area of opening of the

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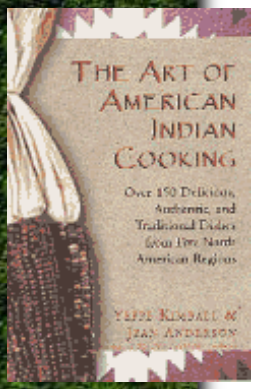
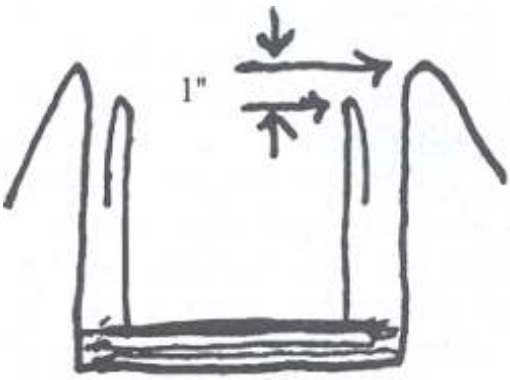


Side view of the solar cooker in action

inner box (length times width) should equal 120 to 160 square inches, and it should be 9 to 12 inches deep. The larger box, the outer one, must be two to three inches larger in all directions.

The oven box



The top of the inner box must rest one inch lower than the top rim of the outer box

For collectors, find four flat pieces of regular (not double strength) cardboard from appliance or bicycle stores. These should be about two feet by three feet. And gather five to seven more boxes which you will cut up for insulation.

Other things to gather:

1. Eight ounces of white paper glue (such as Elmer's™).
2. One small roll of 18" wide heavy duty aluminum kitchen foil.
3. A piece of double strength glass ½" larger than the length and width of the inner box (about $2 to $3 at a glass store). Buff the edges of the glass by rubbing a rock or metal over them, so they're not dangerously sharp.
4. A small amount of flat black paint.
5. (For square oven only:) One yard of elastic band material, say 3/8" wide, from a sewing store.
6. A baking tin that fits in the inner box, preferably one that puts a slight pressure on the sidewalls, to form a rack.
7. Some cotton cloth from recycled clothes.
8. Some string.

Take the outer box and cut up cardboard pieces to fit in the bottom (cut the cardboard with a mat knife, being careful not to cut yourself). Make these layers thick enough so that, when the inner box is placed in the outer box, the top rim of the inner box is one inch lower than the top rim of the outer box.

The outer box must have two opposite flaps left sticking out. Tuck the other two between the inner and outer boxes. The inner box must have all of its top flaps bent out and all the way back so that they fit between the inner and outer boxes.

Loaves of solar-baked bread

Now cut more pieces of cardboard to stuff between the inner and outer boxes until the inner box is wedged tightly. Doubled-over pieces look nicer.

The tops of these filler insulation pieces must be arranged so that, when the glass rests on the top rim of the inner box, it makes a good seal. (That is, you don't want big gaps where the heated air will escape.) Also, it must be easy to slip a finger under the glass for easy removal. In use, the cooker will be tilted toward the sun. Therefore, the sidewall, which will be lower when it's tilted, must be arranged so it will support the glass in position.

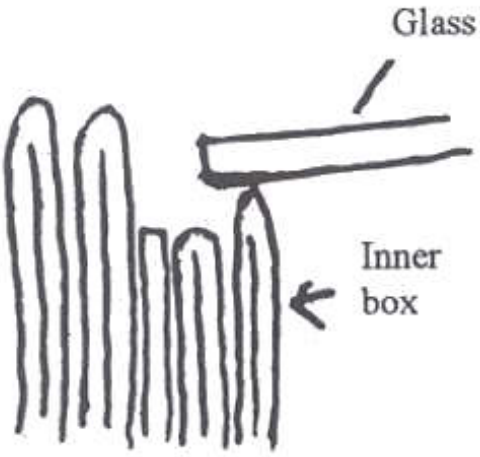
Now paint the inside black. Optionally, you may cut handholds in the outer box and squirt glue under the cuts to keep them from tearing out.

Note for later: The box will smoke slightly during the first couple of times it is heated up, but this is just a curing process. Also, cardboard shrinks slightly when heated, so you will have to repack later to keep the inner box tight.

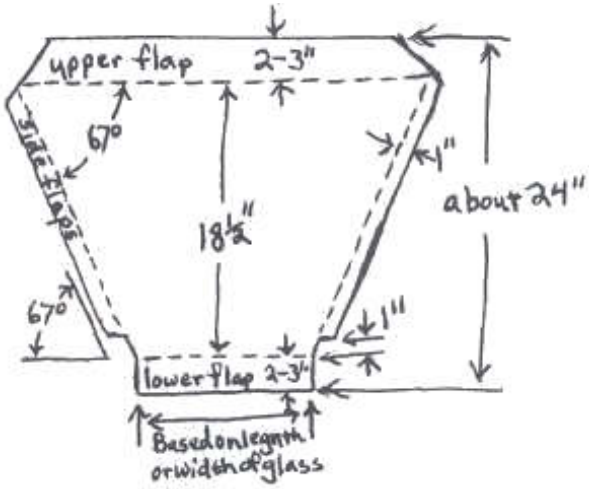
The collectors

Draw the collectors, as shown, on the four flat pieces of cardboard. A square cooker will have all four collectors the same size, while a rectangular cooker will have two sizes, based on the length and width of the glass. The 67° angle can be found using a protractor, or by folding a piece of paper like an airplane, as shown in the diagram.

Cut out all four collectors. Then take a tool with a blunt point and crease a line along the dotted lines. Bend in on



Arrange the filler pieces so the g lass rests on the top rim of the inner box, and so you can slip a finger under the glass to remove it.



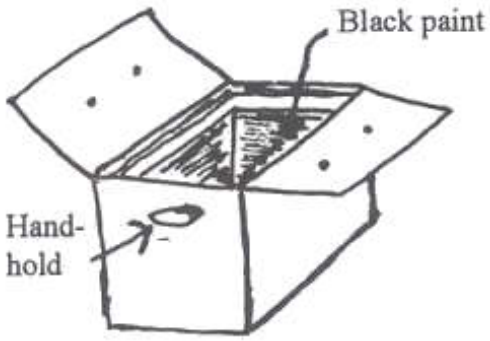
Here's the pattern for the collectors.
The dimensions will depend on the dimensions of your box.

the crease lines. Next, bend the upper and lower flaps all the way over and glue them down. Press with weights until the glue dries.

Gluing aluminum foil to the collectors

Roll foil over the collectors, and rub your finger over the side flap bends to show where to cut. Cut the foil so that it does not quite reach these bends; it will be easier to center later. Do not cover the side flaps.

Smear a glue mixture (two parts water, one part white glue) over the dull side of the foil, using a piece of cloth and two to three tablespoons of glue mix. Line up the collector and lower it onto the foil, tap it lightly, and turn it over. Apply the foil to the side of the collector that is not glued to the bent-over upper and lower flaps. Being a little off center is okay, but if it's off too much, peel off the foil and try again. Press on the edges of the foil and pull out large wrinkles. Take a clean cloth and rub outward on the foil to smooth it.

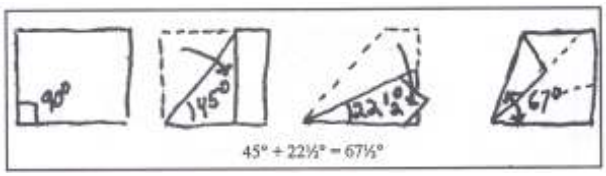


Leave two of the flaps on the outer box out, so you can tie the collectors to them when it's windy.

Connecting the collectors

For a rectangular cooker, set collectors out as they will fit on the box and glue the side flaps together on two opposite corners. When the glue has dried, poke holes in the side flaps on the other two corners, placing holes near the cardboard bend, and tie these corners together with a cotton cord. When it comes time later to fold the collectors flat and pack them away, the rectangular collectors will be untied and separated into two sets of paired collectors.

For a square cooker, glue two opposite sets of side flaps together, as below. Then lay them out as they will fit on the oven box. Cut off the side flaps from one of the unattached corners. Connect this corner by laying these two collectors next to each other (about ¼" apart), with the foil sides down. Now cut a cloth about 18" x 4" and glue it over this corner, as shown. When the glue is dry, fold inward on this cloth hinge and arrange the collectors so that the unattached side flaps are on the outside and line up with each other. Poke holes near the bends of the side flaps, and tie the two segments tightly together with elastic material. This will allow these corners to separate slightly when the collectors are folded flat, but pulls the corners together when unfolded.



You can find the 67° angle by folding a piece of paper as shown here.

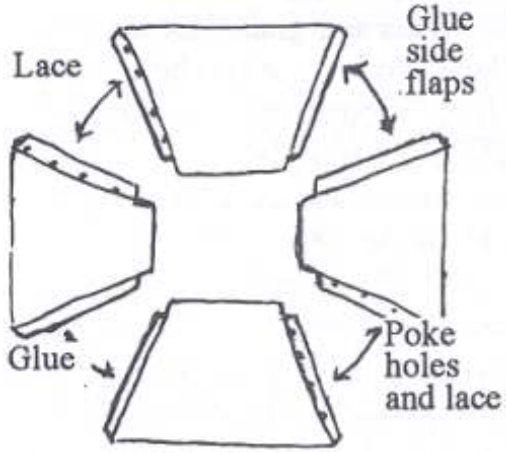
The slip-in piece

A slip-in piece made from cardboard and cloth is attached to the upper collector. This slips between the cardboard filler pieces of the upper sidewall for quick attachment of the collectors to the oven box.

To make it, cut a piece of cardboard 16" one way and the length of the glass the other way. Crease two lines and bend as shown. Then cut a piece of cloth six inches one way and the length of the glass the other way, and glue three inches of the cloth inside the folded cardboard (leave three inches outside), as shown. Next, glue the cloth that was left out to the upper collector (glue it to the doubled-over lower flap of the collector). On square collectors, this would be to the right of the cloth hinge

Finishing up, setting up

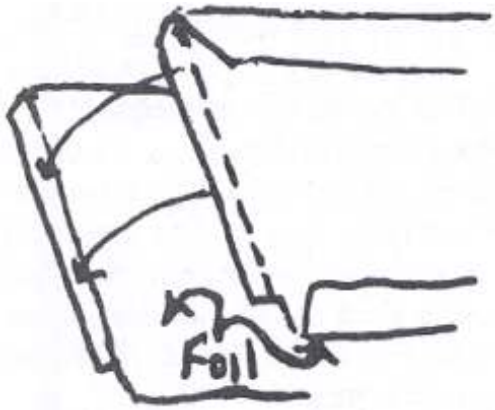
The rack: A dark baking tin is used for a rack to hold food and catch boil-over. It's nice if the rack puts a slight



Connect the collector panels with glue and with laces.

pressure on the sidewalls, for stability. If the baking tin has handholds, these may be bent for a better fit. You can also build a rack from wood, or by bending sheet metal. The glass: Check again to see that it rests on the top rim of the inner box with no large air gap. The glass will become hot, so handle it by the edges or use a cloth. Keep the glass clean. Remember to buff the edges so they're not sharp.

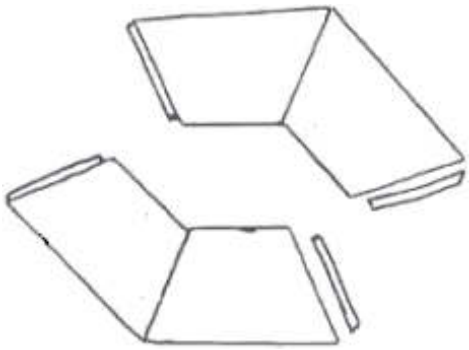
Propping the oven toward the sun: Use rocks or other objects in front and back. If you use only one, the wind easily tips the cooker.



The side flaps are glued together with the foil sides facing each other.

Aiming: Use shadows created by the cooker to orient it; don't look at the sun. Approach the cooker from behind, checking shadows on the sides for east/west adjustments. Touch the oven box and see where the shadow line from the collectors crosses your arm for up/down adjustments. Aim the cooker in front of the sun's path.

Wind: Poke holes in the flaps left out of the oven box and also in the collectors on the top and bottom. Tie collectors to flaps with cotton cord.



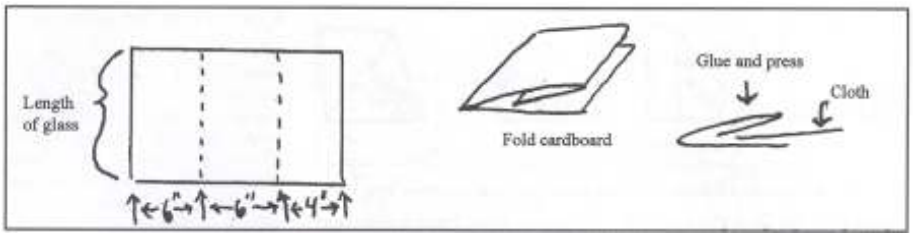
To make a cloth hinge for the collectors: First, cut off the side flaps from one corner.

Next, glue the cloth to the panels

Cooking

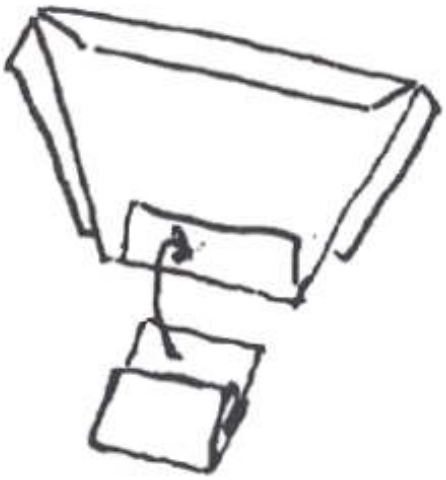
Jars: Boil and steam food in recycled jars, half-gallon or smaller in size. Painting them black will reduce cooking time, but leave a clear strip to see food by using tape when painting.

When cooking, don't overfill jars with beans and grains, as these foods expand. You can poke a hole in the lid or leave it on loose to avoid pressure buildup. If food is actively boiling, open jars slowly to release any built-up pressure. I've never broken a jar because of pressure buildup. If a lid sticks, tap around the edge, or pry up under it, to release any vacuum pressure. It should then open easily.



Making the slip-in piece

Hinged collector panels in the folded position



Attach the slip-in piece to the upper collector

Learn to cook with more than one jar at a time. Start with the longest-cooking food, and when it is boiling, add more jars. Learn which foods (grains, potatoes, squash, lentils, etc.)—and what quantities of them— you can cook in one pass, so you can cook when you are gone all day. Learn cooking patterns that fit your lifestyle.

Beans: Use 2¼ cups of water for 1 cup of beans. If you boil them actively over a long time, add more water. Pintos take the longest.

Grains: Most grains cook better if you preheat the water in the solar cooker for an hour or so. Use a two-to-one water-to-grains ratio. Long grain rice can be put in the cooker in cold water.

Vegetables: These cook in jars with little or no water, or they can be added to beans and grains. Potatoes and sweet potatoes cook well on the rack, if lightly oiled. Otherwise, put them in jars. Winter squash cooks in its own skin. Corn on the cob steam-bakes in its own sheath.

Bread: Bread cooks best in dark, one-pound coffee cans. Oil the cans. Let dough rise in the cooker without collectors attached, then add the collectors when you're ready to bake. Bread shrinks, so it will come out of the cans with a gentle tapping when it's done.

Pizza and pies: Bake the crust first.

Etc.: Try jams, cinnamon rolls, cake, corn bread, cookies, and other munchies, as well.

When the food is cooked, you can fold the collectors down over the glass. This provides good insulation, so the food stays hot until you are ready to eat.

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The Solar Cooking Archive

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30% of purchase price donated to spreading solar cooking around the world!

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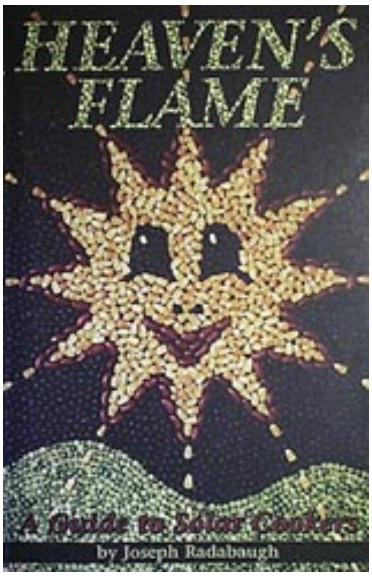

This excellent 144-page book offers a great, comprehensive introduction to the world of solar cooking, including a large question and answer section, a long chapter detailing who's who, and detailed plans for a very high-performance cardboard cooker and detailed cooking instructions. You can see an example of this cooker here.

You can read an excerpt from this book here.

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Solar Cooking -- A Primer/Cookbook

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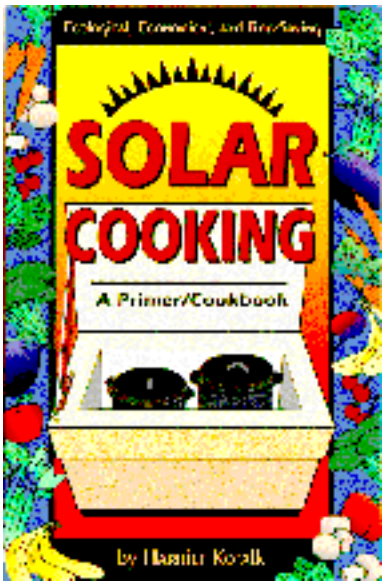

A 96-page book of natural vegetarian recipes. Contains 24 pages of background including construction plans and cooking tips. Barbara Kerr, the inventor of the cardboard solar box cooker writes of the book, "The combination of the enhanced flavor of solar-cooked foods and Harriet's lovely, carefully balanced recipes is a total win!"

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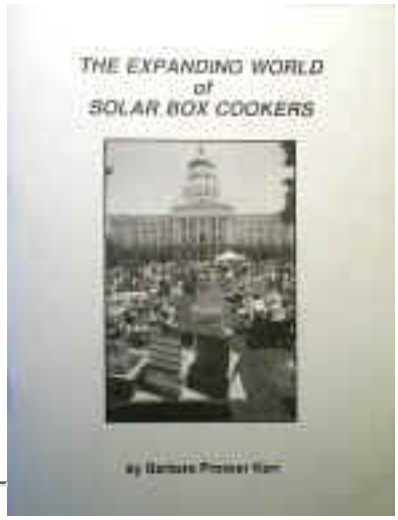
The Expanding World of Solar Box Cookers



by Barbara Prosser Kerr

Available online here. To order a printed copy, which includes photos and diagrams send $15 US to this address:

Kerr-Cole Solar Box Cookers
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Or email kerrcole@skyboot.com

Cookbooks

Cooking with Sunshine -- The Lazy Cook's Guide to Solar Cuisine

by Lorraine Anderson and Rick Palkovic

Eighty-four pages of recipes, organized into 30 menus, including main courses and desserts. A special "Warm Ups" section introduces children to the wonders of solar cooking. Includes a brief history, theory of solar cooking, where to find additional resources, and building plans. Index of recipes and main ingredients.

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Eleanor's Solar Cookbook

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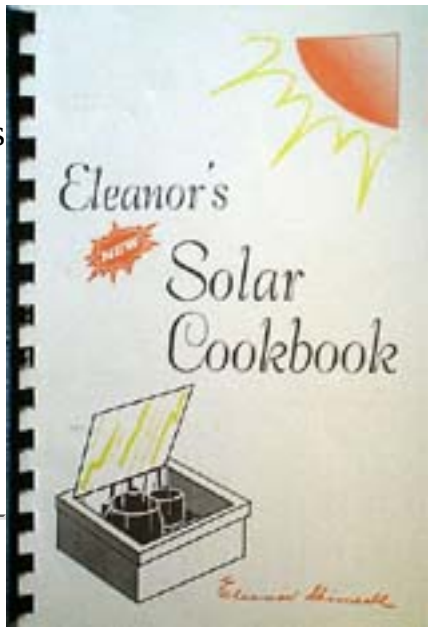

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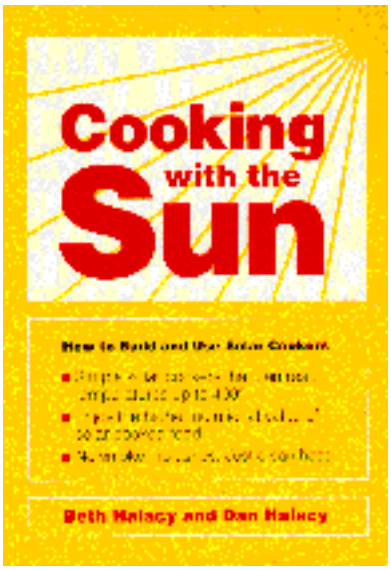

A 115-page book with plans for building a plywood multi-reflector box cooker, a cardboard single-reflector box cooker, and a cardboard parabolic cooker. Contains 62 pages of American and international recipes.

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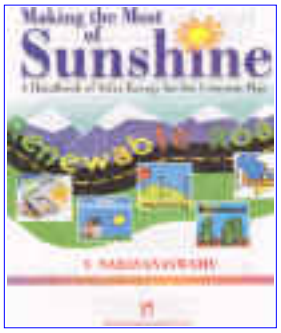

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Chancen solarer Kochkisten als angepasste Technologie in Entwicklungsländern

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by Ursula Bremm-Gerhards

A 140-page book (in German) showing the designs of various types of solar cookers, including box-type and parabolic. Gives a detailed description of major on-going solar cookers projects around the world and an in-depth discussion of the successes and stumbling blocks of each project. Includes a very complete bibliography of books of interest to the solar cooking community.

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or

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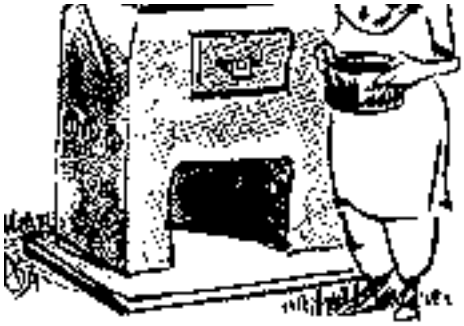
Technology Handbook: Mud Solar Cooker

by the Energy Environment Group (New Delhi)

The Energy Environment Group in New Delhi has published a

bilingual Hindi/English construction manual for a mud solar cooker made from bricks, mud, and dung. The cooking chamber is made from a kerosine tin and is insulated with straw. This design is presented as an alternative to the government subsidized cookers, which they believe were ill-designed for rural energy requirements and traditions.



Available for $10 from:

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Das Solarkocher-Buch

Angefangen bei einfachsten Kochkisten bis zu solaren Großküchen bietet dieses Buch einen ausführlichen Einblick in die Welt des solaren Kochens.
Neben den Erfahrungsberichten kommt aber auch die Praxis nicht zu kurz: außer einer ausführlichen und gut illustrierten Bauanleitung werden zahlreiche, in Deutschland erfolgreich erprobte Rezepte mit Farbfotos vorgestellt und mit Tips ergänzt. Außerdem bietet das Buch eine umfangreiche, illustrierte Marktübersicht sowie eine internationale Adressen und Literatursammlung.
1995, Format: 21 x 21 cm, 98 S., 45 Abb., teilweise vierfarbig, 32 DM.

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SOLAR COOKERE RANNA (Cooking with Solar Cooker)

In Bengali language with a synopsis in English available

By Satyapriya Mukhopadhyay, Ph.D.
Sr. Lecturer in Bengali
S.K.College
Bagula, Nadia, West Bengal
INDIA

Residential Address:

18A, Ballygunge Station Road
Calcutta – 700 019
West Bengal
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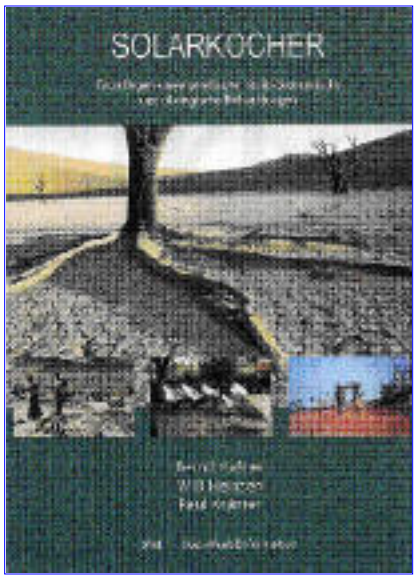
Discusses different types of solar cookers used throughout the world. Photographs. History of solar cooking with references. General

information about how to solar cook. Presents detailed menus with discussions for solar cooking for seven days. Following these instructions will give a solid basis for solar cooking. View Table of Contents.

Solarkocher. Grundlagen, Praxis, sozio-ökonomische und ökologische Betrachtungen



Bernd Hafner, Paul Krämer, Willi Heinzen

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PREFACE

The goal of being in harmony with nature led me to what has become a life's dedication of research in Solar Box Cookers. The publishing of The Expanding World of Solar Box Cookers represents the development and growth of Solar Box Cookers (SBCs) along with the practical knowledge and the potentials of SBCs generated during the past 17 years. Hopefully, this book will fill the need for background information so designers may utilize our fund of knowledge as they work to design locally appropriate SBCs.

I am greatly indebted to Sherry Cole, my good friend and business partner in solar box cookers. She had the initial vision and has held it firmly over the years. The quiet mainstay of the work, she has been unstinting with her financial and emotional support. She has devoted herself to personally handling both the office from her home in Tempe, Arizona and the production warehouse for the EcoCookers and kits in South Phoenix. She has been irreplaceable in critiquing, proofing and

editing my designs and writings. Most of the time, she has appeared to have had the time of her life, radiating joy, carrying us through the highs and lows of years of effort. But, it seems to me that I got the best, most fun, part of SBC pioneering work in tinkering with designs and eventually establishing the Kerr-Cole Experimental Home in Taylor, Arizona.

Sherry and I are particularly grateful to Renz Jennings who made the "worm barn" on his ranch in south Phoenix available to us for storage and also for use as the production base for all our solar box cookers and kits. Without this gift, which has continued over the years, we could never have produced our lines of wooden Patio SBCs and cardboard EcoCookers.

We are also indebted to Dr. Robert Metcalf, his wife Mary Beth and sons Tom and Jim. Bob has deep practical experience with SBCs through cooking main meals for his family during every summer season since 1978. He also has a firm commitment to seeing solar box cookers used to reduce human suffering and environmental devastation and has inspired many hundreds of people in the Sacramento area and elsewhere to adopt the convenience of solar boxes. Since 1978 he has supported and guided students in the study of various aspects of solar box cooker technology; and has been a national and international advocate/ambassador for the use of SBCs. At California State University, Sacramento, where he is a professor of Biological Sciences, he was asked to present the Livingston Annual Faculty Lecture in part because of his work with SBCs. He devoted his 1990 Sabbatical year solely to solar box cookers and is current president of SBCI.

Further, we are indebted to Bev Blum who had the original vision of a nonprofit educational organization for SBCs. The group of deeply dedicated volunteers organized Solar Box Cookers International. Under her guidance this volunteer organization has disseminated knowledge of solar box cookers, allowing for the technology to be adapted to a variety of forms suitable for meeting local needs and customs world wide. She has nurtured SBCI through its tender initial development and is now faithfully shepherding it through its "awkward age" of rapidly expanding growth.

I deeply appreciate the generous permissions received from Heidi Kirschner, MD, SBCI, Mark Aalfs and Tom Sponheim to republish material from their work, including a representative selection of plans.

Others too numerous to mention have contributed money, time, energy and wisdom. With their enthusiastic input, the solar box cooker effort has soared. Integrating solar box cookers into our homes has established the validity of the vision. This book is offered to them with thanks.

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Barbara Prosser Kerr
July 1991

INTRODUCTION

The Expanding World of Solar Box Cookers is targeted toward people who are familiar with solar box cookers and the literature distributed by Solar Box Cookers International and Solar Box Cookers Northwest. Probably most readers will have extensive experience in daily solar cooking as well as with building their own SBC. Nevertheless, I hope it will equally serve the interested SBC neophyte. The first eight chapters, by far the largest section, will focus on the rich detail surrounding this emerging technology; the last two chapters will give several fairly simple cardboard plans and instructions for using a solar box cooker along with beginning recipes.

Responsibility for the contents of this book and the form it has taken rests solely with me. I ask that my readers inform me as to any errors identified and new information obtained by their personal experience so corrections and updates can be incorporated into future material.

I assume some sections of this book may be read without reference to the whole. Therefore, I ask also for tolerance of sections where safety precautions have been repeated in different contexts. Nevertheless, safety in the use of techniques in this book is the responsibility of the SBC user.

CHAPTER 1

HISTORY

Solar box cookers (SBCs) are the earliest form of solar cooking in Western culture. An early European record of cooking in a solar box was made by Horace de Saussure, a Swiss naturalist experimenting as early as 1767. He reported successfully cooking fruits at that time with initial temperatures of 189.5 F (87.5 C). Over the years, de Saussure and others focused their solar box cooker design work on variations of shape, size, sidings, glazings, insulations, reflectors, and the composition and reflectance of the internal surfaces.

These components have been varied endlessly in an effort to increase solar box temperatures. Our solar boxes now successfully reach temperatures between 275 -300 F (135 -149 C), depending on size and location of use. Since many foods will cook with an internal temperature of 190 F (88 C) and water boils at 212 F (100 C) at sea level, it is clear that solar box cookers have reached adequate cooking temperatures for a long time.

Meanwhile, the higher temperatures of cooking over fire have continued to force us to stir foods and protect them from scorching from excessive bottom heat, while needless amounts of fuel and human labor have been unnecessarily used. Now, we can do better than that by using readily available, free solar energy whenever the sun shines.

At the time I was first exploring solar cooking, my home was dedicated to developing Earth-Conscious Homemaking. I was exploring all the ways that could be used in an urban home to reduce consumption of earth resources. As a part of this effort, I made and used a lot of solar cookers. At one time I had seven different types of solar cookers and some duplicates in my back yard. Most were homemade. There were various parabolic and non-parabolic troughs, one five foot dish parabolic concentrator, and several four-reflector slant-face ovens—one made from the Halacy plans. There was the beautiful octagonal Solar Chef designed by Sam Erwin. Almost daily,

neighbors and friends would join me for potluck dinners using the solar cookers.

When I put together my first solar box cooker in March of 1976, I had simply heard that an Indian designer, Ghosh, had made a solar box that cooked, but I had not been able to obtain plans or illustrations of it. Unaware that it "should" be made of metal or wood, I used cardboard boxes and thus opened a new line of SBC development. Had I been more knowledgeable, I would not have been so surprised that it cooked very well, if somewhat slowly, at its initial temperature of 240 F (115.5 C). With improvement in the thermal dynamics of the box, 300 F (149 C) was reached, a more than adequate temperature for boiling, roasting, baking, and gentle frying...surely a solar kitchen range.

During June and July of that year, Sherry Cole, my good friend and neighbor, and I faced a definitive test for solar box cooking. We had a large social action group in our homes. In addition to office and sleeping space, we offered to provide meals for the volunteers, planning to use the backyard solar equipment as much as possible.

Meeting the daily food needs of 35 to 40 hungry adults presented a perfect opportunity to compare the practicality of the various solar cookers. It provided fine tests of comparative function under stress. Our choice of cooking apparatus gradually shifted away from the multiple reflector and parabolic cookers to solar box cookers. While we initially had been aware of some of the special qualities of solar box cooking, it was through the routine serving of large quantities of food that the major strengths of the solar box technology emerged. They reliably cooked large quantities of food but required minimal attention. With a hectic schedule, it was not possible to give focusing cookers the attention they required. When attention lapsed, the focusing collectors would go out of focus and the food would not be done when needed. In addition, little gusts of summer wind would close or topple the multiple reflector cookers—again resulting in partially cooked food. But if food was placed in a solar box cooker early in the day, we were assured cooked food at mealtime.

Our parabolic and multiple reflector cookers came to be used only for foods requiring shorter cooking or warming periods, preferably while someone was close at hand to tend them. They ended up being used mainly for optional dishes, while solar boxes became the workhorses for cooking the main dishes. An additional solar box cooker or two would have done as well or better at meeting our needs than my yard full of the more intricately designed cookers. When using solar box cookers, once the food was in I could give full attention to other chores. In addition, on the few semi-cloudy days, food in the SBCs cooked much better than food in the cookers that depended more heavily on reflectors.

Although solar boxes have been used for home heating, water heating, and distilling, the box design has not yet been widely used for cooking. Perhaps this is because solar boxes are so unassuming; it is hard to jazz up a large, simple box to appeal well in advertising. It needs to be seen in action to be believed. But solar box cookers have clearly demonstrated their effectiveness when it comes to meeting food service needs whether it be for individuals or groups, households, schools, businesses, or other organizations.

Sherry Cole identified the widespread value of such a device. We joined forces to tell as many people as possible about solar box cookers. As the effort began to attract media attention, we had a string of visitors, including several from the engineering department of the nearby university. Earnestly and with all good intent, I was advised to drop the solar box as it was an inherently

inefficient design. One good-hearted engineer sat next to a solar box that was quietly and cheerfully cooking a large pot of beans and told me that "solar boxes just won't cook," and proved his point by referencing a scale in a technical book he had brought along!

This experience made it clear just how different our design goals are from engineering approaches. Engineering approaches and available literature often emphasize maximum solar collection at the expense of simplicity, functionality, appropriate materials and ease of use. Such designs do not lend themselves to being used as routine home appliances, nor can they be built without special tools and skills. Our design goals emphasized simplicity in design and construction easy for nonprofessional builders, the use of appropriate and available materials, ease of operation, and dependability under a wide variety of conditions. Our cardboard designs assumed the use of recycled materials and minimal additional costs.

After it became known that Sherry and I had experience with inexpensive solar box cookers, we were approached by two elementary school teachers. They wanted us to produce a lightweight teaching model made of cardboard that could be taken apart and reassembled repeatedly by third grade students in a special gifted program. They wanted a teaching device and a good cooking unit combined. This work led to the development of the patented Kerr-Cole Solar Box EcoCooker and the production of kits and complete stoves. Although designed for maximum simplicity, the EcoCooker design proved to be a useful teaching tool for all age and educational levels. We received both national and state energy innovation awards on this work.

While we did make wooden models, and still sell plans for a wooden design, the cardboard designs have been most popular. To allow viewers to see the construction details, the teaching model boxes can be completely disassembled. They can then be reassembled in a few minutes to start cooking.

In 1978 Dr. Robert Metcalf, an early SBC user, identified the SBC as a potentially powerful tool for public health efforts to reduce microbiological illness, and as a component for many environmental and social efforts from nutrition projects to tree planting efforts and more. With the full support of his Department Head, he has used his degree in microbiology and his position as Professor of Biological Sciences at California State University Sacramento to lay the scientific base for major expansion of SBC usage. Studies done with his students established the safety, microbiologically, of solar box cooking and the feasibility of water pasteurization by means of SBCs. With the safety of cooking and pasteurization scientifically established, Dr. Metcalf has spoken to thousands and has given hundreds of demonstrations to the academic and environmental community. He has spent private funds to travel to Washington, DC and elsewhere to speak to and demonstrate the solar box cooker for key people in government and private volunteer organizations. He and his wife have opened their home to travelers from all over the world coming to see the incredible cooking box.

Dr. Metcalf has donated hundreds of hours of his private time to give speeches and demonstrations. He interested Dr. Fred Barrett of the United States Department of Agriculture and together, with funds from US-AID, they prepared a video, "Four Square Feet of Sunshine," which introduces the concept of solar box cooking and its potential benefits. He also had a major role in preparation of the video, "A Bright Future." He recruited numerous friends, including Dr. William Sperber, from the Pillsbury Company, a company which provided funding for an SBC project in

Bolivia as a part of an Applied Nutrition Program with the Freedom From Hunger Foundation. Together with an anthropologist, Dr. Aaron Zazueta, and local Aymarans, in March, 1987, they walked out beside potato fields on the altiplano of Bolivia and held the first international solar box cooker demonstration focused on technology transfer through the use of a functional cardboard model.

Dr. Metcalf also interested Leland Brenneman of PLAN International, formerly Foster Parents Plan, and worked closely with him as well as Dr. Sperber during a second Pillsbury-sponsored international project which was held in El Progreso, Guatemala in January, 1988.

Although the work by Sherry Cole and myself was progressing, it became clear that many more resources were needed to spread the knowledge and practice of solar box cooking. SOLAR BOX COOKERS INTERNATIONAL (SBCI) was formed in 1987 as a non-profit volunteer organization to respond to inquiries and provide central coordination of volunteer donations of time and money, develop educational materials, and promote knowledge of the technology and use of SBCs worldwide. Our goal came to be to make solar box cooking as widely known as cooking with fire. SBCI publishes a newsletter covering the broad aspects of what is happening in the SBC field. Their work is closely coordinated with SOLAR BOX COOKERS NORTHWEST (SBCN). Formed in 1989 in Seattle, SBCN publishes a fine quarterly newsletter specifically on solar box cooking, with reports on SBC activities around the globe. SBCN also coordinates an on-going international computer conference on EcoNet dealing with appropriate technology in general and SBCs in particular. Through these organizations, numerous volunteers with a broad spectrum of skills and professional qualifications have donated hundreds of hours of work. Through their efforts in providing workshops and literature, information on SBCs is now moving out to people all over the world.

The educational materials that SBCI has produced, which are available from their office, have greatly multiplied the effects of individual volunteers in the spread of knowledge about solar box cooking. But perhaps their most important contribution to date has been development of a training system and a workshop outline with materials to assist individuals in teaching others how to build and use SBCs to cook with the sun. These organizations deserve all possible support.

Information on other solar cooking efforts in many locations and with diverse designs has been gathered and published by the German Appropriate Technology Exchange. It appears at this time our effort is the one most heavily focused on technology transfer.

CHAPTER 2

BASIC THEORY AND STRATEGIES FOR USAGE

In practice, all one needs to produce good solar cooked meals is a common sense understanding of a solar box cooker. Solar cooking a few familiar recipes soon makes using an SBC easy. Since it helps for solar box cooker designers and teachers to have a more detailed understanding of solar cooking, solar radiation, solar heat production, heat traps and heat transfer, these items will be covered at length in this chapter.

"Solar box cooker" is used in this book as a generic term which covers any of many designs of solar cooker characterized by a large, insulated, horizontal cooking chamber with a glazed window

on the top to allow sunlight into the insulated box. Usually there is one reflector stabilized by an adjustable prop to reflect additional sunlight through the window. Customarily the reflector is part of the lid. Solar box cookers may be constructed of any serviceable, nontoxic materials. The inner box and glazing must also be heat resistant.

Three BASIC NATURAL LAWS are employed in making and using solar box cookers. One natural law is that when solar radiation (sunlight) strikes a dark surface it changes to infrared radiation (heat). A second natural law is that when light falls on light-colored or shiny surfaces it reflects and so can be directed to where it is needed. A final natural law is that solar radiation (sunlight) passes through a transparent window easily, but infrared radiation (heat) does not, so heat can be trapped. "Sunlight, the energy resource that powers photosynthesis and drives the earth's weather, is the foundation for all life on earth. Energy resources such as coal, oil, and gas, formed from solar grown organic matter, are not renewable and will be consumed in a tiny fraction of the millions of years required for their formation. Although solar energy is a diffuse resource, its effective use has been documented since the time of the Greeks, the Romans, and the ancient cliff dwellers of the North American Southwest. As we deplete our non-renewable energy resources, we must continue to develop ways to use solar energy directly.

"Throughout history, humans have applied solar energy principles to provide for a variety of needs....As we approach the next millennium, the problems of world hunger, contaminated drinking water, deforestation, and the fuelwood crisis, are becoming more acute. The invention and use of simple, inexpensive, and low-tech solar box cookers, have resulted in the emergence of solar cooking as a solution to this variety of problems.

> "With an understanding of basic principles of heat flow and access to simple materials such as cardboard, aluminum foil, and glass, one can build an effective solar cooking device...."8

HEAT PRINCIPLES

The basic purpose of a solar box cooker is to heat things up—cook food, purify water, and sterilize instruments, to mention a few....

> "The basic heating dynamics are:
>
> A. Heat gain
> B. Heat loss
> C. Thermal mass

A solar box cooker cooks because the interior of the box is heated by the energy of the sun. Given this heat input, the temperature inside of a solar box cooker will continue to rise until the heat loss of the cooker is equal to the solar heat gain.

Given two boxes that have equal heat loss, the one that has more gain, from stronger sunlight or additional sunlight via a reflector, will be hotter inside.

Given two boxes that have equal heat gain, the one that has less heat loss—better insulated walls, bottom and top—will reach a higher interior temperature.

The most efficient use of solar radiation by SBCs is determined by the location of heat production both directly and through the use of reflection and by the competence of the insulation retaining the heat thus produced. Both direct and reflected sunlight passing through the glazing onto a dark pot produce heat on the pot sides which flows directly into food since heat naturally seeks to equalize temperatures by moving from hotter areas into colder areas. Sunlight also falls on the reflective oven sides and the dark bottom of the oven. Reflective sides in an SBC throw additional light onto the dark pots in the center as well as adding to the sunlight on the dark drip tray.

A reflective bottom will reflect sunlight up the sides and back out through the glass without it ever becoming heat. For this reason the bottom of solar box cookers is customarily dark. Then even if there is no dark pot in the oven, heat from the dark tray rises to preheat the oven air. A totally reflective oven will not get very hot unless there is a dark object inside.

Cold air is excluded and the heat produced is trapped by insulation in the sides and bottom of the SBC as well as by the glazing and the close fitting lid. The hot oven air transfers additional heat to the pots. The temperature range an SBC will achieve is determined by a combination of all these factors, as well as by others discussed in Chapter 4.

Don’t get overwhelmed with all these details which are provided to give background for trouble-shooters, educators, researchers and designers. Actual cooking consists of putting the food in a dark, lidded pot, pointing the SBC at the sun and giving it sufficient time to cook. That is all most people need to consider when using their SBC.

The MAXIMUM TEMPERATURES for empty SBCs focussed in full sunlight range from 220 F (104 C) to 300 F (149 C) and occasionally above. Temperatures always temporarily drop when the ovens are opened and particularly when cold food is put inside. They immediately begin to heat the food which keeps the temperatures naturally low until the food is hot. Cooking occurs at any point above 190 F (88 C); boiling temperature is 212 F (100 C) at sea level, lower at higher altitudes. Any SBC which reaches 250 F (121 C) or above is considered a good model. Ovens peaking below that level take longer to cook and do not brown food but may be very serviceable.

COOKING TIMES are effected by a number of other factors in addition to the caliber of SBC. An SBC’s function varies with sun angles, sun conditions, location including latitude and altitude, weather and mass. Temperatures are a result of a combination of all these varying conditions so cooking times in written materials are always approximations.

SUN ANGLES are effected by daily changes and seasonal changes as well as differences in sun angles dependent on the latitude. During the early morning and late afternoon with their lower sun angles, foods clearly cook more slowly than during mid-day. When the shadows are long, cooking times will be longer and it will not be possible to finish hard to cook foods, or large quantities of food without special care. It is not necessary to wait for optimum sun angles to utilize an SBC. Preheating of food can be done by the low angles of the morning sunlight, while food that is already hot and cooking will continue to cook in late afternoon at low sun angles.

The most frequent special approach to SBC cooking with a low functioning SBC and/or low sun angles is to heat food briefly before putting it into the SBC for the remainder of cooking time.

Angles also change slowly as the daily arc of the sun swings higher or lower across the sky over the seasons, with best cooking capacity in summer and reduced cooking capacity in winter. With

regard to seasonal changes in sun angles, we are revising our expectations as we hear from SBC users. Individuals can use SBCs for single servings when family quantities might be impossible. As winter comes on, the solar cook begins to feel when solar cooking of the foods and amounts needed can no longer be done.

Areas of 20 LATITUDE or less have year-round solar box cooking angles and proportionally less as one goes further from the equator. By about 30 latitude, there is a noticeable drop in sun angles in the winter but easy to cook dishes can be prepared any sunny day. At about 40 latitude, cooking is easily possible 7 to 8 months of the year in Sacramento (Sea level 38.5 N. Latitude). In Seattle (Sea level, 47.5 N. Latitude), they have found that reduced quantities of food can be cooked even in January. This is at a far higher latitude than our early experience led us to expect winter cooking. A 5 pound (2.25 kg) chicken was cooked in Seattle on November 2, 1989, which was a windless, sunny day. They were using a homemade SBC of the SBCI Eco-design with double oven cooking bag in double glazing. There is also a report of cooking a full meal in mid-February in Seattle. Neither of these cooks was using any special cooking methods.

Thus, for well over half the year, assuming solar cooking in the south latitudes is comparable, the area of potentially effective solar box cooking reaches from lower Canada in the northern hemisphere almost to the tip of the South American continent in the southern hemisphere. In brief, geographically this covers all of Afghanistan, all of the African continent, all of the Arabian peninsula, all of Australia, all of Central and South America except the very most southern parts of Chili and Argentina, most of China, southern portions of France and Italy, all of the India peninsula, the Hawaiian Islands, all of Japan, Indonesia, Mexico, most of the Middle Eastern countries north to the level of Bucharest, parts of New Zealand, Pakistan, the Philippines, southern portions of the Soviet Union, all of Spain, Sri Lanka, and Thailand, as well as all of the United States. This list is only representative of the areas of the globe for reference by people from various locations and does not represent all the territory where SBCs could be used. Also, this list does not consider local factors such as persistent cloud cover, severe air pollution, etc., which will eliminate some areas.

ALTITUDE, as opposed to latitude, has little effect except perhaps to provide somewhat better sun conditions as the atmosphere and pollution thins at higher altitudes. Yet, because water boils at lower temperatures, cooking some foods may be slower at higher altitudes. It has been reported that these factors seem to balance each other out and solar cooking proceeds at high altitudes much like anywhere else. Solar box cooking definitely has been accomplished at 12,000’ altitude, 15 latitude in March. On the Bolivian altiplano, rice was reported to cook more rapidly than it would in Sacramento with the same sun angle. Their small potatoes as well as their fish were delicious.

SUN CONDITIONS also effect cooking time. Bright, clear sunlight is obviously the most powerful. With the solar box design, cooking can continue but more slowly when there is some reduction in sunlight due to cloud cover or overcast conditions, high humidity, and air pollution including smog and dust. Sometimes cooking can be improved by simply moving the SBC away from the side of a road, to where it is sheltered from traffic pollution by a building or a tree. During harmattan, cooking was successful in Sierra Leone in January.

MARGINAL WEATHER is not a great problem. A full sunny day is not required for cooking in a solar box oven, in contrast to primarily reflective solar cookers. Sunlight must be strong enough

for a fairly distinct shadow. SBCs use indirect as well as direct radiation and so can cook, although more slowly, under somewhat overcast conditions. Likewise, when there are intermittent clouds, but with full sunlight for roughly 30% or more of the time, cooking will proceed in a solar box, although more slowly. This wide range of radiation used by solar box cookers is one reason the designs are particularly suitable for serious solar cooking. They can be depended on to produce cooked food for a large portion of the year in most of the world's temperate and tropical zones. On a completely cloudy day or one with less than 30% sunshine, traditional methods can be used.

On a semi-cloudy day, easy to cook foods may be chosen or food may cut into small pieces, or divided into several pots. If necessary, foods can be started with hot water, or even brought to a boil before placing in the SBC. If miscalculation or changing conditions leave the food not quite done, a little conventional fuel can finish cooking the meal.

MONSOON solar cooking may be possible simply by identifying the bright hours and adapting to the length of cooking time available. For instance, during the monsoon season in Arizona, there are usually about two hours of bright early morning sun before clouds close in. Easy to cook foods started early can be well begun or often completely cooked in this limited sunny time. Moderately hard or hard to cook foods may brought to a boil by other fuels before being placed in the SBC. Or just as the clouds arrive, pots which are fully heated and cooking in an SBC can be converted to retained heat techniques by packing insulated cushions around the pots inside the cooker. See the Retained Heat section in this Chapter.

When it is WINDY AND COLD but sunny, SBC cooking is slowed somewhat by chilling as wind moves across the glazing. On a bright, very cold, still day, one need only allow extra time for cooking. When it is cold AND windy, a second layer of glass or other glazing ¼ to ½ inch (6 to 12 mm) above the first glazing is essential. It creates a layer of still hot air to insulate the window. Sometimes an SBC lid and prop must be tied on, or the whole oven braced with rocks to withstand gusting winds and yet it will still cook. Water condensed on the inside of an SBC window may simply be wiped off periodically with a soft cloth. Condensation on the window is more often due to cooking without a tight lid than to weather conditions. Thin glazings that flutter in the wind are less effective than rigid glazing, either glass or plastic. For more about windows and glazings, see the glazing section in Chapter 4.

The MASS within the oven insulation—walls, tray, pots, and food—all make a difference in cooking time. The well-insulated oven, lined with foil-covered cardboard, having a light metal, dark colored tray has very little mass as compared to a wooden or metal oven lined with sheet metal or having a heavy metal tray. Both will heat, but the thick sheet metal will require longer to heat initially and will cool correspondingly more slowly when sunshine is reduced. The same considerations apply to pots. Thin-sided, darkened stainless steel or graniteware pots start to cook quicker than heavier ceramic, tinted or painted glass, earthenware or cast iron containers. However, due to heat stored in the thermal mass, once the food is cooking in the heavier cast iron and ceramic pots, it will continue to cook through intermittent clouds better than thinner pots. Once the mass is hot, all pots cook similar foods in about the same time.

These construction and equipment details cause some of the variations in the cooking ability of various stoves. They also make it clear why under most circumstances adobe, brick or ceramic walls do not make a good interior siding for solar box cookers...too much heat goes into the walls

of the stove rather than into food.

In addition to the mass of the oven and the pots, another important consideration is how much food mass is being cooked and the shape of the mass. Large mass, say 10 pounds (4.5 kg), in one pot will cook more slowly than the same mass divided into two or three pots. Whole potatoes or meat in a large solid piece cook more slowly than the same foods cut into smaller pieces. For cooking regularly under good solar conditions, it does not matter much how heavy the pot or how the mass is distributed—heavier and thicker simply takes more time. But if cooking conditions are marginal, a thin pot with food cut into small pieces may cook when more massive configurations do not. Although aluminum pots transfer heat quickly and are available around the world, I hesitate to recommend them because as yet scientific studies have not been done to establish if significant amounts of aluminum compounds enter the food when cooking for the lengths of time required by SBCs.

Extra mass is sometimes temporarily added to an oven to store heat for a rapid start, as when cooking breads. Additional mass also provides stabilizing heat during days with variable clouds and stores additional heat for holding foods after sundown. Bottles of water may appear to be a better choice than rocks, adobe bricks, railroad spikes or cast iron pans for heat storage because water can store the most BTUs. However, the maximum temperature unpressured water can reach is the boiling point, 212 F (100 C) at sea level. Although it takes about 5 pounds (2.25 kg) of bricks to equal the heat storage capacity of 1 pound (0.45 kg) of water, bricks can store heat up to the maximum temperature of the SBC. This provides a higher temperature and greater quantity of stored heat which is available for breads or other foods when they are first placed in the SBC.

The strategy of using mass should be varied depending on the needs in a given situation. If there is ample sun and ample time, putting food and extra mass in all at once is a labor saving combination of steps. However, heat forming in the oven will go equally into all available mass. If food is put in alone first, all available heat will flow into it, which starts the food cooking more quickly. Mass added after food is up to temperature utilizes excess heat not going into the food and so does not delay cooking.

RETAINED HEAT cooking goes hand in hand with solar box cooking. In traditional retained heat cooking, a fairly large amount of food in a pot with a tight lid is brought to a boil and simmered for 5 to 30 minutes depending on the type of food being cooked. (See "Simmering Times," page 13). After simmering, the food is quickly moved to a well insulated box and packed with light, clean pillows of insulation. Care is taken not to disturb the lid so steam does not escape. Cooking levels of heat will be retained for up to four hours. In two to three times the usual stove time, food is cooked by the retained heat. This technique works well with 3 pints (1.4 liters) or more of food mass, but small recipes may not retain heat for sufficiently long periods to complete cooking and may have to be reheated after an hour or so.

When combining retained heat and solar cooking, if food has gotten thoroughly hot in an SBC, but clouds arrive before the food is finished cooking, a switch from solar to retained heat cooking should be made before the oven temperature drops below the boiling point. For large recipes this may be accomplished by simply closing the reflective lid on the pots of cooking foods. For smaller recipes, the solar oven is opened,taking care not to allow steam to escape from under the lids, pots are pushed close together along with any heated additional mass. Insulating pads or soft cushions

are tucked closely around the pots and well heated mass. The SBC lid is then closed. This effectively makes the transition from solar to retained heat cooking for small quantities. The cooker lid remains closed until shortly before serving time, when the food is tested. If not completely done, a very little conventional fuel will usually finish the job. As a caution, if the mass is not well heated to the core, it may absorb some of the heat from the food and so quickly lower the overall temperature and delay cooking.

Usually solar/retained heat cooking is done right where the SBC is located. However, a lightweight portable SBC can be moved temporarily indoors for its retained heat cooking time if the sun clouds over or if it rains. It may also be brought inside more or less permanently during the off season or at night and function as an insulated box for retained heat cooking. Used in this way the SBC continues to save fuel rather than simply being stored until conditions are right for solar cooking.

Some of the ADVANTAGES OF RETAINED HEAT cooking over conventional cooking are that it uses reduced amounts of fuel, reduces the amount of attention directed toward cooking, and food can be prepared any time, day or night under any weather conditions. This procedure is well worth exploring in different areas of the globe and works very well in conjunction with solar cooking.

FOOD SAFETY with regard to retained heat cooking has been studied by Dr Kirschner. She states, "Cooking with retained heat in a fireless cooker means that the food cooks while the temperature drops very slowly. I have checked innumerable times, using many different amounts and types of foods and sizes of pots, and found that for up to 4 hours—and often much longer—food stays steaming hot in the cooker, and the temperature is at or above 145 F (63 C) .... Should you want to leave the food in the cooker for longer periods ...bring it back to the boiling point and simmer it for 5 minutes to be absolutely sure it won’t spoil."

Food safety for food cooked by any method requires meeting specific rigid conditions. Cooked food at temperatures between 125 F (52 C) and 50 F (10 C) can grow harmful bacteria. This temperature range is known as the danger zone. To protect against food poisoning, microbiologists and home economists strongly recommend that food be kept either above or below these temperatures. These precautions are the same whether food is cooked with gas, electricity, microwaves, wood fire, or solar heat as well as foods cooked by retained heat, crock pot, barbecue pit or any other method. In cooked food held at room temperature, there is a chance of Bacillus cereus food poisoning, a major intestinal illness. Worse, if the food is not thoroughly reheated before consumption, there is a chance of deadly botulism poisoning or salmonella. Even if it is reheated, when cooked food has been in the danger zone for three to four hours, there remains a risk of food poisoning3 in solar cooked food as in food cooked by any other method.

It has been carefully documented with regard to solar box cookers that it is safe to place raw refrigerated or frozen food, even chicken or other meat, in an SBC in the morning several hours before the sun begins to cook it. Refrigerated food placed in an SBC remains sufficiently cold until the sun starts to heat the SBC. Once the full sun is on the oven, the heating of food proceeds quickly enough so that there is no danger of food poisoning.2 Uncooked grains, beans and other dried raw foods can also be placed in an SBC in advance. Both of these methods facilitate absentee cooking.

There are three main points at which caution is required: it is dangerous to keep cooked food more

than three or four hours in an unheated or cooling SBC unless both the SBC and food have been cooled rather quickly to below 50 F (10 C) in which case the SBC is serving as a cool box; it is dangerous to let cooked food remain overnight in an SBC unless it is likewise cooled; and it is dangerous for food to partially cook and then remain warm in the SBC when temperatures are not sustained as might occur on a poor solar cooking day, at the end of the day or when clouds move in. Cooked or partially cooked food should either be cooled to below 50 F (10 C) or cooking should be finished with an alternate fuel. If food has remained in the temperature danger zone for 3 to 4 hours it should be considered spoiled and should be discarded. Reheating the food does not correct the problem as heat does not inactivate all toxins.

Food does not have to be visibly spoiled in order to be toxic and cause illness evidenced by nausea, vomiting and diarrhea. Even if food has not been at the incubating temperatures of the danger zone for the full 3 to 4 hours, absolutely discard food that is bubbling, foaming, has a bad smell, is becoming discolored, or gives any other indication of spoilage. Discard it out of reach of animals and children and thoroughly wash the pot. Discard it without tasting it as even small amounts can make an adult very sick.

If temperatures below 50 F (10 C) cannot be obtained, it is still valuable to drop food temperatures as low as possible and as quickly as possible rather than allowing food to remain warm since bacteria grow more slowly at lower temperatures.

An alternative method of holding cooked food is to reliably maintain the temperature of the entire food mass above 125 F (53 C). This can be achieved by first heating the food to boiling, simmering for a few minutes to allow heat to penetrate to the center of each particle and for a pocket of steam to collect under the lid. Then proceed as for retained heat cooking. This provides the level of temperature needed throughout the food, whereas leaving a pot of food on a very small flame may allow food at the edges to remain in the danger zone. Where neither of these methods can be used, it is best to cook amounts of food that will be consumed in one meal relatively soon after being cooked.

ADVANTAGES OF SOLAR BOX COOKING over both conventional cooking methods and retained heat cooking are that it uses only sunlight most days. SBCs can cook large or small amounts of mass. A wider range of pots can be used in an SBC, since an absolutely tight lid is not required, although recommended. And SBCs can produce delicious boiled, simmered, baked, or roasted and lightly browned food with a more varied texture.

FUEL SAVINGS with either solar cooking or retained heat cooking as well as with the solar/retained heat combination can be significant. In India, families using SBCs regularly reduce use of conventional fuels or firewood by about half. In Arizona the fuel saving is more than that. It has not been formally calculated for many places but families using solar box cookers as their major stoves become adept at using what sunlight is available to reduce their use of other conventional fuels such as firewood, gas or charcoal to a minimum.

SBCs have been well received in a great many areas. The solar box cooked food often duplicates or at least closely approaches the traditional flavors, but some regional foods may take careful trials to match customary textures and flavors. Acceptance of SBCs sometimes depends on discovering the best solar box cooking method for favorite local foods. A very small group, or even one individual, can pioneer solar cooking in an area. This can be a social pleasure as well as

test a lot of recipes.

In addition to cooking traditional foods, the SBC offers opportunities for cooking foods in different ways in more versatility, so that new recipes may be used. Such recipes may or may not be traditional, but certainly can be very good. Baking breads, cakes and cookies can be a particular delight where baking is not customarily possible. Experimenting can be fun. Most Americans enjoy Chinese, Japanese, Mexican, Middle Eastern and other different foods as well as any of the foods encountered while they grew up. The popularity being experienced by American fast food chains as they expand into other countries highlights the ability of traditionally habituated palates to accept new tastes.

Flavoring is a delicate process. Some of the differences in taste can come from cooking methods. Browning onions, garlic and other spices prior to adding the remainder of the ingredients induces a different flavor, subtle but important in some stews and casseroles. Rice and other grains must have the familiar texture as well as the right flavoring to satisfy—that is, to taste "right." Since people in each locality can taste the subtle differences in their foods, local pioneer solar cooks are in the best position to test different methods. Experimental cooking can be done, using any of at least seven different approaches and the results compared for the best flavor.

1. Put all ingredients into pot at the beginning...get it on early...don’t worry about overcooking. This is the SBC standard, trouble-free method and usually works well.
2. Heat the pan perhaps with a little oil, then add the uncooked ingredients... Good for steaming fresh, moistened leafy greens according to some; others like their greens only when in a bath of delicious cooking water. Preheating the SBC and pans is also good for cooking most breads and starting meats.
3. Bring water to simmering, then add air temperature food—raw grain or meal or heavy vegetables. Stir mushes, grits and porridges well initially and stir again after a half an hour or so. Stirred at those two points, then they can cook unattended as long as necessary without burning or sticking. Vegetables like broccoli, cauliflower or green beans cook well dropped into steaming hot water for 5 to 10 minutes, then drained and kept in a pot in the SBC for another half an hour or so. Soups or drinks may be made with the cooking water to preserve nutrients.
4. Bring water to simmering while separately heating the dry ingredients in the SBC. When both are hot, combine them and cook for reduced amounts of time. The consistency of pasta is greatly improved by this method, particularly if a little oil is stirred into the pasta before heating. Sauces can be prepared in this way for dishes which are simply not the same if all cooked in a single pot. Sadza, the staple made from ground white corn in Zimbabwe, may be made this way. Hot corn meal (Mealy meal) is added to near boiling water in proper proportions, and vigorously mixed for about a minute to achieve the proper texture. Some rice that becomes mushy if cooked from the beginning in water, comes out with separate grains when heated separately and combined to cook for a shorter period.
5. Briefly precook selected ingredients over a small fire...Saute garlic and other spices and herbs before combining with the rest of the dish and putting it in the SBC. If a difference in taste is due to the absence of browned flavor or of smoke, this may provide just the needed touch.
6. Add some ingredients near the end of cooking...grated cheese, some spices or herbs, butter,

vinegar, etc.

7. Prepare new recipes for solar cooking using traditional ingredients.

If certain traditional foods cannot be duplicated, reserve those recipes for cloudy days when former cooking methods must be used.

Anyone developing a special cooking method for a challenging local food, please write to Solar Cookers International to share your recipes with others

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CHAPTER 3

PATTERNS OF USAGE

Integration of SBCs into the lifestyles of individuals takes many forms. None of the uses are mutually exclusive and, in fact, most people enjoy the flexibility they present.

Briefly listed, here are some of patterns we see:

- Seven different SBCs are lined up on the lawn of a social activist. The air wafts an enticing blend of peach blossoms, crushed grass and lasagna. After the program, 50 to 80 people feast on the solar cooked food...and consider it an outstanding fund-raiser.
- A farmer fills an SBC full of jars of water, one jar with a pasteurization temperature indicator. The farmer then takes a couple of cooled jars of yesterday's pasteurization run to drink in the field. On return after sundown, the temperature indicator shows today's water is safe so it is stored. If anything had interrupted the pasteurization process, the indicator would have alerted the farmer and that run would have been processed again the next sunny day. Meanwhile, safe water is ready to drink from the supply of stored jars.
- In Sierra Leone, a group of women gather to make soap which later they will sell in Freetown. In Zimbabwe, the product is ginger cookies. In Sedona, U.S.A, it was a small organic, solar bakery for cookies and miniature bread loaves.
- A family of 8 leaves their Sunday roast beef dinner in their SBC and returns from church to eat immediately. If their regular wooden SBC becomes full, the remainder goes into a small cardboard SBC which "seems to cook just as well." On recreational outings, the portable one cooks food and holds it hot, ready whenever someone comes in hungry.
- In the dawn in Scottsdale, U.S.A., a woman carries pots of frozen pork chops covered with barbecue sauce and baking potatoes out to her SBC before she leaves for the University. When she returns in the evening, after a brief rest she quickly whips up a salad, loads perfectly cooked food from the SBC to the table, and serves the four adult males in her family. Thanks to the SBC she can pursue graduate education to prepare for the changes in her life when the teenagers leave home.
- A retired woman anticipates savory meals as she sets up her tiny, gourmet solar recipes for the day. Measuring 3 tablespoons of brown rice and some dried mushrooms with herbs into one darkened half-pint jar, and a quarter cup of lentils with seasonings from her bulk storage into another little jar, she happily plans she can eat solar food, each varied dish especially flavored just as she likes it, for the rest of her life ... all cooked free in the sunlight.
- An energetic homemaker clears breakfast and moves to set out a rice and cheese casserole

for lunch and a bean pot for supper before going out to the garden. A pot of water also in the SBC will be ready for her hot drink and to steam fresh greens when she comes in to serve lunch. While the greens are steaming, she will mix corn bread that will cook in the afternoon and be great with the beans for supper.

- A marginally employed carpenter makes a wooden SBC which he arranges to leave in the yard of a family where the wage-earner is temporarily disabled and unemployed. The destitute family will prepare food from his bags of bulk rice and bulk beans and watch over the SBC in exchange for a solar-cooked dinner. At the end of an exhausting day, he will have an economical, delicious meal with friends.
- A college student arriving home with unexpected company whips a frozen dinner for each of them out of the refrigerator, removes the insulating foil and puts them in her SBC covering them with a second dark cookie tray. After they have finished studying, two hours later they chow down.
- Fourth grade students casually roll out their SBC and focus it as their teacher unlocks the small private schoolroom. Each puts a lunch into the solar oven to heat. As usual, at noon they gather under the big tree to feast and to trade nibbles.
- A shop crew steps out back to get their solar burritos for lunch. Someone has put in nachos half-an-hour ago which are ready for dipping in salsa.
- Attracted by the smell on her way to the door of the Energy Assistance Office, a woman carrying a small child twists her head to see a bubbling pot of stew and a cake baking....in a box?
- A man lies quietly on the beach next to his SBC, resting while his fish bakes.
- At the Retreat Center, scheduled groups approach the SBC every half an hour for a brief introduction to solar cooking and a hot mushy, chocolate schmore.
- Haunted by always burning her beans, a woman finds peace of mind in her SBC knowing that her solar bean pot is not scorching, the pot will not have black in the bottom and her husband will declare today’s beans delicious.
- Carefully balancing her tray loaded with pots of raw chicken, rice and carrots, a little girl approaches the SBC she built for science class. Tucking the pots inside her solar oven and focussing the reflector, she dwells on the satisfaction of making real food for supper. Her mother smiles out the window confident the food will be ready on time even if the child forgets to do anything else with it.
- A small, gray-haired woman strolls beneath the large trees in her yard to where her SBC is cooking on a wheelbarrow. She rolls it to the afternoon patch of sun, removes her "microwave" meal for lunch and leaves her three-grain casserole cooking for friends who are coming later in the day.

Such vignettes only hint at the variety of uses made of SBCs. The final example, The Sustainable Emergency Kitchen, will be covered in more detail since it can be worked in a number of different ways and can serve as a pattern for recreational or vacation cooking, or it can meet serious emergency needs on a long term basis. Savory food can be created from either fresh or stored food supplies for months or years while requiring a very minimum of fuel by using an SBC in combination with retained heat cooking augmented by small wood fires and with flint and steel on

dry cotton fluff or some other method for quickly starting flames.

Equipment for an emergency must be as simple and labor-saving as possible, sparing energy and time for other critical activities. An emergency kitchen must be versatile and adequate to function one way or another any day or at night if needed. Rain, blizzard, wind, or any emergency must not interrupt the flow of nutritious cooked food for a family.

Many people plan to cook on a wood fire in an emergency. Yet there are problems with this. Many traditional cooking fires take large quantities of wood—an unrealistic demand at this time in history. As stores are depleted, wood may need to be gathered locally and carried home. Manual gathering and transportation of cooking fuel is strenuous work, exhausting and time-consuming. Utilizing mechanized methods of firewood gathering requires gasoline, lubricants and replacements to keep a truck and chainsaw functioning. All of these are products of a smoothly functioning industrialized economy and may not be available in certain areas or even globally during a longstanding emergency. Even with the help of a pack animal, moving fuelwood is heavy, bulky work. With exhaustion of the supply, fuel gathering must be done at greater and greater distances, and at increasing expense of time and human energy.

Furthermore, the numbers of people in our present populations can denude an area very quickly, leaving the earth stripped of the protection of trees and shrubs. Widening circles of devastation are growing today around many population centers where wood and charcoal are heavily used for cooking. It will take generations for the land to recover from such overuse if it is ever possible under the changing circumstances.

It is essential to plan to protect our remaining fuelwood trees by holding fuelwood cutting and gathering below the level of natural replacement so that our natural tree cover can grow back and the land return to a healthy condition. It also makes good sense to plant especially fast-growing fuelwood trees around the home in advance of any actual need since they take several years to grow. Mature fuelwood trees and orchard trimmings, if used sparingly, can do a wonderful amount of cooking, particularly if the wood is burned in one of the many varieties of improved woodstoves.

Solar energy is a non-consumptive and non-polluting fuel which is delivered freely and even in excessive amounts in the areas where most people live. The solar box cooker can be the heart of a sustainable emergency kitchen. The SBC would be supplemented at night or on cloudy days with retained heat and small wood fires. In addition, the Sustainable Emergency Kitchen may include a variety of solar water heaters, a solar water and milk pasteurizer, and/or a solar food dryer. There might also be an organic food-producing garden and food producing solar greenhouse.

Small wood fires differ from regular campfires and from most traditional wood stoves in that a minimum of wood is utilized. Gathered wood is often ½ inch to 1 ½ inches (1.25 to 3.75 cm) in diameter...a common branch size and a common size for kindling. In a good stove, four or five small sticks at a time are sufficient. The flame is concentrated in one spot directly underneath the pot. Pans are placed directly over the flame which carries more heat than embers and is available immediately. A variety of fuels can be used—branches and twigs, pine cones, scrap lumber, twists of papers, strips of cardboard, dry corn cobs, dung—all in the same type small wood stove.

In recent years a great deal of effort has gone into designing efficient small wood stoves and there

are many different designs. There are also some efficient home made designs that have been used over generations.

When using a single pot fire for multiple dishes, work through the menu, cooking the food that will take longest first, bringing to a boil and then simmered according to the schedule prepared by Dr. Kirschner. As each pot is removed from the fire, it is wrapped in a soot cloth, sack or paper bag before placing it in the retained heat cooker. When all foods are sufficiently heated and packed away, smother the fire to conserve the unburned ends for next time.

A new flame can be made almost as quickly as with a match by striking a spark onto a small fluff of very dry loose cotton or other very good, dry tinder. The initial flame can be used to ignite a roll of paper or very thin piece of wood to use as a taper.

Learning to cook using sustainable emergency kitchen equipment and techniques is not really very complicated. Practice helps make this a simple process. The value of SBCs as emergency cookstoves and as retained heat boxes does not detract from their use for recreational cooking, for fire safety, for keeping the home cool in the summer time, for reducing utility costs, etc. All these and more are legitimate reasons to incorporate SBCs into a homemaking routine. Using solar box cookers for fun or convenience when there is no emergency can organize the necessary equipment and can produce a very useful skill. Having an SBC in regular use makes it easy to cook through times of emergency with a minimum of disruption.

CHAPTER 4

INDIVIDUAL DESIGN ELEMENTS

This chapter on Design Elements will detail as fully as possible our experience to date. It gives an informed base on which additional information can accumulate as the expanding field of solar box cookers continues to grow.

The Kerr-Cole EcoCooker cardboard design, patented in 1980, for years has been a standard. Assembled it measures 29" x 25" x 11" (72.5 x 62.5 x 27.5 cm). With 3 inches (7.5 cm) of foil and crushed newspaper insulation, it is fitted with one piece of single strength window glass 24" x 20" (60 x 50 cm). The base is built with two open-topped boxes, insulated, then covered with "toppers" that stretch over the outside, across the top and down the inside of the assembly. This makes a very substantial cardboard SBC which still remains a peak performing model. In the Temperate Zone it reaches temperatures between 275 to 300 F (135 to 149 C) and performs even better in equatorial locations. This design has been widely popularized by SBCI through excellent educational materials, home building plans, and workshops. (See plans in Chapter 9, Part A).

In 1990, Mr. Joe On of Sacramento suggested a design requiring less materials. The JoeOn design is simplicity itself: after tracing the outline of a smaller box onto the closed top of a larger box, one simply cuts out the traced hole and inserts the former into the latter. (See plans in Chapter 9, Part D). The dimensions vary depending on boxes available, but often they are much smaller than the Eco. Generally the wall thickness is reduced to 1 to 2 inches (2.5 to 5 cm) and plastic glazing is used making a smaller, lighter model. Maximum temperatures range from 220 F to 275 F (104 to 135 C) and occasionally above. While the design does not have the years of service behind it and is considerably less substantial than the EcoCooker, it is quicker to build, preheats rapidly and

given adequate time, normally cook very well. There are a number of designs developed following this general pattern and very satisfactory SBCs are produced.

A third line of designing involves two strips of panels and formulas for adapting to a wide range of dimensions. (See plans in Chapter 9, Part B). This relatively new development is included here since it conceptually may serve to stimulate thought toward many different models: homecrafted from scraps glued together or panels of different materials as well as possibly being adaptable for mass production particularly to meet emergency needs. The dimensions can be set to the size of glazing available, or to the customary pot height for an area, or to a predetermined width of cardboard or other material. Given a particularly good available outer box, the strip pattern can be used to build a fitted inner box. The designs of the lids are similar for all three SBCs except for the variety in props.

These three lines of designing do not exhaust the field. Many efforts have been made toward designing a collapsible model and one, which performs very well, is ready for general marketing. Another design, a cylindrical form, is also in production. Neither of these lends itself to handcrafting.

Designers should use these illustrations only as background information and freely combine solar box components using whatever materials are available in a way that meets the needs of their own people.

The SIZE is important. For serious solar cooking for a family or group, SBCs need about 3 square feet (0.27 square meters) of window glazing to function adequately, cooking a maximum of about 10 pounds (4.5 kg) of food on good sunny days. Four square feet (0.36 sq. m.) is preferable for a really good, multiple-purpose solar box cooker as it will cook about 12 pounds (5.4 kg) of food. Large cookers will continue to cook although lesser amounts on semi-overcast days.

Smaller SBCs having smaller glazed areas collect less solar radiation, have limited pan size and often lower maximum temperatures. They can not heat as much mass as larger SBCs. While they may cook amounts suitable for one or two people, they usually can not handle sufficient food for a family or small group, unless several small SBCs are utilized. Small ones have generally been more of a recreational oven rather than a major appliance for food service. They have their place in the family of solar box cookers perhaps for easy transportability, for demonstrations, for school projects or in cooking for a single person but just don’t expect a pony to do the work of a horse. Small versions clearly have wide potential for use by isolated individuals, the homeless, or transients who cannot deal with the bulkier standard size and have no need for the quantities of cooked food they can produce.

For special times, SBCs of any size can be gathered into one location to produce food for a crowd. Sixty to 80 people on many occasions have been served from SBCs gathered in Dr. Metcalf’s backyard in Sacramento for his gala, delicious "Solarques."

Collapsible models of SBCs being designed are opening an entirely new field of development as they combine larger cooking capacities with smaller storage needs and much easier transporting.

The DEPTH is determined by the height of the tallest container to be used, plus 1 inch (2.5 cm). Broad, shallow ovens take less material and heat more quickly. They have a higher solar gain collector area to heat loss surface area ratio. With greater heat gain per heat loss, the effective heat

will be greater and temperatures will be higher as well.

For maximum cooking area, the sides are perpendicular. Slanted interior walls provide slightly higher temperatures in the center but restrict the area on which pots may stand sometimes making the use of cookie trays, large roasters, or more than one pot impossible. Slanted sides are also much more difficult to build than perpendicular ones..

The SHAPE of an SBC can be rectangular, square, round or oval. Rectangular and oval SBCs have a broad side facing the sun for maximum collection of sunlight as the sun passes overhead. This makes the best use of reflected light, as well as direct sun, and reduces the need for changing focus. Square SBCs are efficient ovens and have the added advantage that pieces for all sides are similar. Rectangular ones seem to pack and transport easier than square, particularly as they can be picked up easier by small-framed people.

Round and oval SBCs are intriguing and skilled craftworkers have produced them. So far no written plans for an effective homecrafted version have been seen. One of the problems is securing a reflector to the curve of the oven without losing too much sunlight on the top surface. There are also problems making a round frame and perhaps obtaining round pieces of glass for the glazing. Round and oval forms without reflectors could be a good choice near the equator where reflected light is less essential.

Corrugated CARDBOARD is widely available in some parts of the world for recycling. It makes a fairly durable, biodegradable unit. If new, it is often inexpensive, especially in urban areas. Cardboard is rigid, lightweight, and has good insulation qualities. It cuts easily, glues easily and yet has sufficient structural integrity for the purpose. Like heavy cloth, leather, and some basket-making fibers, it will form its own hinges without hardware. It is not expected that all homemade SBCs will be made of cardboard, only that it meets the needs of the SBCs in which it is used. Pressed paper board has also been used but is more difficult to work.

The exterior siding is often different from the interior. Wood exterior and cardboard interior makes a very functional combination. Wood is biodegradable, yet weather resistant and durable. Wood/cardboard combination SBCs have been cooking since 1978 with minimal upkeep. Completely cardboard ones have been cooking for eight seasons so far with one cardboard SBC still cooking after eleven years! These have, of course, been protected from rain. Often these units were untreated, but some had a commercial white kaolin coating. Water-resistance of cardboard is increased by coating the SBC with oil, fat, or petroleum jelly and placing it in the sun until the coating penetrates. Other exterior weather resistant coverings are contact paper and house paint.

The most appropriate SIDING will depend on the materials and skills in an area and are based on availability and/or cultural norm. The complete range of siding materials has not been established and is an important area for local investigations. It is crucial that the material for the inner box not give off toxic fumes or strong odors either cool or at cooking temperatures. The exterior of an SBC may be made from any paneling available.

For good stewardship of Earth resources, biodegradable sidings such as cardboard, wood, natural fibers, earth and adobe are encouraged.

Cardboard ovens appeal to many, particularly environmentalists. Ultimately they are almost completely biodegradable. When the design is homemade, cardboard, often recycled from bins

behind hardware and grocery stores, can be transformed into a major home appliance—the cook stove. If cardboard is not available, many other lightweight materials may be substituted. And free fuel, the sunshine, is available most of the year for most of the people on the planet.

Adobe, dung or mud/dung mixtures that have been formed into thick slabs or bricks are suitable for exterior sidings. Dung is needed primarily for returning to earth as fertilizer; however, if it is being gathered and burned, its use to make SBC sidings to reduce the loss from continued burning seems justified. Other vegetable fibers mixed with a nontoxic adhesive, could be pressed into a forming mold to make slabs. When earth or adobe are used in a siding, it is important to insulate the inner box from the earth mass otherwise the heavy earth will act as a heat sink keeping the oven below cooking temperatures. There are reports from Zimbabwe of people placing a boiling pot in an uninsulated adobe box, covering it with a glass and thus continuing to cook by solar energy for the remainder of the time needed. Zimbabwe extends from approximately 22 to 15.5 South Latitude...a Sunbelt land. We do not have any reports of placing cold, raw food in uninsulated adobe and successfully solar cooking it.

Thick quilts or cloth pillows may be shaped into the oven form, allowing a large part of the SBC to be spun and woven. Filled with carded wool, cotton or other fiber and sewn together, care must be taken that there are no heat leaks at the seams, perhaps by overlapping to eliminate cracks or thin areas. It might be necessary in Equatorial locations to shade the outer cloth in some way to prevent deterioration by ultra-violet light.

Woven cloth dipped in oil or grease was historically called oiled-cloth and used for rainwear (known as "slickers") and for containers to store perishable materials on shipboard. Similar oiled cloth could be used for exterior sidings of SBCs. Dried animal skins have made containers for many people over the years and probably could be adapted to solar box cookers. When such materials are used, stitching the shape together and sealing the punctures with natural resin might work better than gluing.

Basketry outer forms work where skill and materials to produce them are available. A paper mash siding could be made of recycled fibers as for egg cartons. Some egg cartons are vacuum-formed from large vats of paper fibers. This process might be adapted to production of SBCs locally.

The pit solar oven simply utilizes a hole dug in the earth as exterior siding, along with good insulation, such as pine needles or hay, and a reflective inner box. The lid and glazing may be standard, although in equatorial areas, the reflector may not be needed.

INSULATION in SBCs with the inner box/outer box construction is usually accomplished by lining the space between boxes with foil. Foil insulation may have patches but the foil should make a complete cover. Wrinkles are no problem if pressed flat. Air bubbles behind the foil make it easier to tear but work alright for insulation. Priorities on the use of limited amounts of foil are as follows: 1) cover the inner oven space including the inner top of the lid around the glazing and the reflector if one is essential, 2) the inside of the outer box and 3) the oven side of baffles. Foil alone is sufficient in many SBCs.

For additional insulation, lightly pack the foiled space with any light-weight, clean-smelling, non-toxic substance. Such bulk insulation is packed loosely as it insulates best if quite airy. Yet it is packed sufficiently tight so that it will not settle over time, leaving an empty, uninsulated space

at the top. Also, with loose packing the sides of the oven are not forced out. A baffle, foiled or not, helps insulate, in part by preventing settling and in part by blocking the convective flow of air. Baffles, which are sheets of cardboard or other material used to partition the insulation space within each wall, are secured approximately in the middle of the space held in place by insulating filler on both sides. A slanted baffle adds to the structural strength but is not significantly better for insulation than a perpendicular one according to work done by Dr. Ed Pejack.

The Pejack study ranks bulk insulation materials from poor to best as crumpled styrofoam cups, crumpled newspapers, straw, wool, rice hulls, and feathers. Field tests on this ranking are not complete, however, styrofoam in any form is not recommended because it is fabricated with chlorofluorocarbons which destroy atmospheric ozone. The newer gases substituted in making styrofoam are untested for use around food and should be avoided unless it is firmly established they are safe around food at SBC oven temperatures. When styrofoam was used prior to understanding its role in atmospheric ozone depletion, it was considered unreliable as an insulator as it sometimes melted within the SBC wall resulting in a poorly functioning oven. Where styrofoam was successful, the inner oven wall was relatively thick and sturdy so reduced amounts of heat penetrated as far as the insulation.

Crumpled newspaper has insulated hundreds of successful SBCs and is the preferred insulation in many areas. Field work with feathers is limited but seems promising. Loosely carded wool was outstanding in two field uses. Those tests were run with sheep wool, but the texture of some dog wool is indistinguishable. Probably any animal wool would insulate well. Shredded paper, hay and pine needles also have been satisfactory.

Pressed fiberglass insulation serves well. Loose fiberglass batts also insulate well but both present health hazards. Fibers are released while the material is being worked and penetrate the eyes, lungs and perhaps are swallowed. Foam insulation is made with toxic gases which continue to off gas for long periods. For these reasons both fiberglass insulation and foam insulation are not recommended.

Where foil and insulating fill are not available, multiple layers of cardboard either with or without spaces between the layers have produced useful solar ovens. If there are spaces between the layers of cardboard, they may be simply left as insulating air cavities or may be filled with crumpled newspaper or other material insulation. Unless using foil, baffles and lots of air space, a large quantity of insulation is usually needed and can make an SBC very heavy.

To test the effectiveness of oven insulation, heat the oven in the sun until it is quite hot. Then place a hand underneath and on the side beneath the reflector. Shadowed areas do not feel warm in a well insulated oven. If insulation is inadequate, has melted, or has shifted, this can be felt through the exterior wall. If there is question about a side or front area, place something to keep that area in the shade until the test.

INNER OVEN LININGS of foil are our primary choice for the following reasons: it reflects a good proportion of the sunlight onto the pots and it provides reflective insulation around the inner oven holding in the heat.

Some experience indicates dark sides for inner ovens may function as well as shiny sides under semi-overcast conditions but in most areas, reflective sides work best.

Sheet metal oven linings are quite durable and have more mass so make heavier SBCs that are somewhat slower to heat initially. They retain more heat than foil to continue cooking longer through intermittent clouds and at the end of the day than ovens with lighter weight linings. However, if sheet metal extends from the inside to outside the glazing, it will function as a radiator, draining heat from the oven. A thermal break is needed. One useful configuration brings the sheet metal about ½ inch (1.2 cm) over the upper edge of the oven where it may be nailed or otherwise secured (Page 26, Fig. 4). The glazing frame then completely covers this inner metal edge. Also, a metal oven lining should not touch the glass or heat will be conducted out of the oven through the glass.

Galvanized sheet metal may be used inside the oven if desired. SBC temperatures are not high enough to disperse zinc, which melts at 419 F (215 C). Temperatures near or above the melting point cause some molecules to migrate and could pose a health hazard. If making any design of solar cooker that reaches near to the melting temperature avoid galvanized metal inside an oven.

LIDS having either a plug (Page 24, Fig. 1a) or a cap (Page 24, Fig. 1b) work best as they reduce heat loss out of the crack between the oven top and the glazing. Reflectors on the lids are made either the size of the glazed window opening (Page 24, Fig. 2a) or the size of the total top.(Page 24, Fig. 2b) Lids covering the full top have advantages in that as the sun passes, more of the reflected light will fall on the glazing even when the sun is far to the side. Lids the exact size of the glazing begin to lose reflection as soon as optimum focus is passed and so reduce somewhat the non-focused performance. In addition, the smaller lids which can press directly on the glazing do not protect as well as full top sizes.

Lids that hinge at the back edge of an SBC (Page 25, Fig. 3a) reflect some light onto the oven top thus losing potential heat. Lids that hinge at the edge of the oven opening (Page 25, Fig. 3b) throw a greater proportion of reflected light into the SBC resulting in better cooking than those hinged at the back surface.

PROPS need to allow a reflective lid to swing from far forward to far back from the perpendicular. The prop must then firmly brace the reflector in the chosen position against both forward and backward movement. This can be done with strings, sticks, wires or a combination. Props have customarily been secured from the upper corner of the lid to the forward corner of the outer box. This requires a stick longer than the box and is difficult to store. Props that are secured from midway up the lid to midway along the side of the SBC give sufficient stability and are short enough to store within the inner box when the SBC is being transported. Whichever length is used, the methods of adjusting the angle of the lid and fastening it in position remain the same. For some prop designs see Page 18.

Not included in the box on Props, is a simple firm wire bent at the ends to poke into holes in corrugated cardboard or drilled in wood. Small pads of cardboard squares may be glued to the lid to receive the wire ends and these pads replaced as needed, or the wire may go into the cardboard of the box and lid themselves. The wire alone is often sufficient, but in areas of persistent wind, a small cord with tightening device may need to be used as well. Or it may be necessary to use a stick form of prop as the wire acts as a spring in gusty wind.

The prop should be on the "morning sun" side of the oven. This, of course, changes from the northern to southern hemisphere. The point is that as the sun moves, the prop shadow can either

fall onto the ground, or across the glass. The shadow spreads with the dropping sun, and if it falls on the glass it reduces the oven function unnecessarily. This reduction takes place as the oven goes out of focus and therefore is particularly crucial. While SBCs can cook slowly on as little as 1/3 of the full sunlight, if the collection area is further reduced by shadow, cooking power is reduced. This is important when doing absentee cooking, cooking under less than full sun, or with low angled sun as in winter cooking or cooking late in the day. Serious solar box cookers, built to provide meals under whatever available sun conditions, should have all possible solar collection area. Place the prop so, as the sun moves, the shadow migrates toward the edge of the oven, not across the glass—on the east side in the northern hemisphere and on the west side in the southern hemisphere.

REFLECTORS for maximum usefulness should be the full size of the top and the hinges should bend at the edge of the inner oven, as discussed under the section on Lids. (See Fig. 2 on Page 24 and Fig. 3 on Page 25). Typical thin kitchen-weight aluminum or tin foil, not heavy duty, is our first choice for reflectors. When foiling the reflector, some wrinkles are inevitable. Flattened wrinkles and smooth patches do not significantly reduce the effectiveness of a reflector. Air bubbles behind foil are fragile on a reflector and change the direction of reflected light as well, thus reducing the effectiveness of a reflector. Bubbles can be reduced by pricking with a sharp object and pressing air out before glue dries. Any glue on the surface of the foil should be carefully and gently washed off as it will block reflection.

To insure stability, the combined weight of the lid and reflector are designed to be much lighter than the empty oven box. Glass mirror reflectors have proved to be top heavy and fragile as well as producing a blinding reflection. In addition, mirrors function through back surface reflection which reduces the sunlight available for cooking. Sunlight falling on a glass mirror must first penetrate the glass to the reflective surface on the back and then pass through the glass again on the way out. A fraction of the sunlight is absorbed on each pass reducing the amount of solar energy a back surface reflector can deliver to the oven. Front surface reflectors, such as foil or polished metal, reflect a greater proportion of sunlight and are a better choice as they deliver more sunlight to the oven. Galvanized metal is durable and produces a useful amount of reflection without the blinding quality of mirror-finished metal but will dull in time when exposed to acid gases and other air pollutants.

GLAZING is a key component to a successful SBC. All glazing blocks some sunlight. Thicker glazings generally block more sunlight than thin ones. Glazings may be regular window glass or certain synthetic glass-like substances.

Two layers of glazing work better than one as the heated air trapped in the small space between layers acts as an insulator over the face of the oven. Two layers of thinner glass or other glazing with ¼ to ½ inch (6 to 12 mm) air space between provide better insulation than the same thickness combined into one pane. Since the oven face is the point of most heat loss, double glazing conserves significant amounts of heat that otherwise would dissipate. A second glazing also protects the inner glazing from chilly winds. Although it blocks a little more of the light, in addition to conserving more heat double glazing by decreasing the moisture condensing inside the window may eventually allow more sunlight through. The net result is a hotter SBC if double glazing is used, particularly on cold and windy days.

Clear window glass, standard single thickness (2.5 mm), has proved very satisfactory. Thinner glass has less tendency to crack from heat than thicker panes, probably because it heats more quickly and evenly, reducing thermal strains. Plate glass is very heavy and has been satisfactory only when tempered. Some SBC designers choose single glazing for portable models with temporary second glazing as an option for poor weather. Often permanent double glazing is chosen for all-weather SBCs and this is probably ideal where materials are available.

Window glass, although fragile, is usually available in urban areas, while tempered glass and synthetic glazings are specialty materials requiring unique supply lines. Window glass is available around the world and therefore in that respect is preferable. Glass does not degrade in sunlight and if protected from thermal strains and impacts, is more durable than most plastic glazings, even those that are treated against degradation by ultra-violet rays.

Low iron glass allows more radiation to penetrate into the box and makes a hotter oven but is not essential. One way glazing has been found to reduce the function of an SBC according to an engineering study done through Solar Box Cookers Northwest. Recycled automobile glass, particularly flat pieces from the side windows of vans, has been used successfully but even pieces that appear clear may be tinted to some degree to cut down on heat in the vehicle or have added materials to make safety glass. Both tints and all added materials block some solar radiation.

Glass may be tempered if desired although the cost of tempering is so high that occasionally replacing glass may be cheaper in the long run for homecrafted SBCs. Glass that has simple heat cracks may be held in place by silicon sealant or nontoxic glue or a narrow strip of tape. Mass produced SBCs customarily use tempered glass.

The first glazing being nearest the food must be nontoxic to prevent poisonous fumes from entering the food. Glass, of course, is non-toxic. At this time, among the available plastics, the common alternatives to glass are heat-resistant nylon (such as Reynolds Oven Cooking Bags), and polyester or polyethylene plastic films available near the foil section of grocery stores in the United States. Many grocery store plastic films have a polyvinyl base and are not suitable for SBC cooking, but some are clearly labeled made of polyesters or polyethylene. Polyvinyl may release a vinyl-related gas when heated to SBC temperatures for the periods of time needed by SBC cooking. For this reason it is not recommended for use in SBCs unless further research establishes its safety for this specific purpose. Translucent fiberglass sheeting is made with a toxic resin and off-gases for a long time. It is not recommended for inner glazing, however, it is frequently used as outer glazing because of its impact resistance, lightweight and durability.

A large size cooking bag (heat-resistant nylon) can be cut open and glued on a frame to lay on top of the oven under the lid, or may be glued directly onto the lid like glass.

To work a plastic glazing, lay glue around the window opening, place the plastic, pull it tight and hold with masking tape until the glue sets. If desired, make a second glazing on the other side. Masking tape alone will not hold in the heat.

Pull it very tightly to reduce flutter on windy days as that will fan heat out of the oven. Such heat resistant glazings make very light ovens and are moderately durable but in time kitchen-grade plastic glazings become brittle. Thicker, oven-safe polyester glazings, some of which are treated to resist degradation by ultra-violet light, may be available as special order items.

Single strength window pane glass overlapping the window opening by ¾" attached with silicon sealant or glue may be used if preferred.

An oven having a permanent, double glazed window, and a side door, resists wind chill best. Where the top is used as the door, the lid may be built with either a plug fitting down into the oven, or with a cap folding over the edges to help prevent wind from blowing heat out. (See Figures 2a and 2b in the section on Lids.)

Most SBC builders simply glue their glass or plastic glazing onto the cardboard of the lid. The cardboard is slightly flexible, reducing the incidence of thermal cracks in glass, yet providing good protection during handling. Some ovens have been made with a narrow strip of cardboard sandwiched on the outer edge between two pieces of cardboard frame thus providing space for glass. Such frames are either glued or stitched on the outer edge a fingerwidth from the edge of the glass. Glass is allowed to move slightly within this casing and sealant is not essential.

Flexible glazing may be wrapped around a cardboard frame to give the two layers. Cardboard frames are simply laid on top of the oven under the lid.

Alternatively, FRAMES for the glazing may be made of wood. For single strength glass in a wooden frame, a small (1/8 inch or .3 cm) clearance around the edge of the glass as it lays in the frame reduces breakage from thermal expansion. Glass is secured with a flexible sealant. The inner glazing must be well sealed to prevent heat leaking from the oven. Second glazings need a maximum of half an inch (2.5 cm) separation from the inner pane. Many home builders do not permanently seal two glazings together, but simply lay the second glazing, either glass or plastic, above a well sealed inner pane. This arrangement allows easy access for cleaning. Double glass panes if permanently sealed, require at least one small opening from the space between panes to the outside to relieve pressure which otherwise might break the glass.

Frames will be true if the pieces from opposite ends are squarely cut and equal. With equal lengths for opposite pieces, a frame can be squared by using the corner of any book, magazine or commercially cut piece of paper as a guide.

An insulating strip between the glazing frame and top of oven is not essential if the top surface is smooth. For irregular tops, solid commercial insulation strips work well if heat resistant. To make a crafted gasket, lay a bead of silicon sealant, paper mash or similar material on the top edge of the oven, cover it with waxed paper and close the lid. Remove the waxed paper when the sealant has hardened. The Dhauladar design by Didi Contractor uses a double fold of woolen fabric glued to the surface beneath the edge of the glass with a final fold brought up to rest on the top edge of the glass thus thoroughly wrapping the edge of the glass and binding it to the frame. It is a permanent seal as access in this design is through a door in the side.

It is essential that INTERIOR PAINTS used for pots, trays or walls be nontoxic and without persistent odor. Some house paint contains mercury or other substances as a fungicide and should definitely not be used inside an oven. Such paint gives off toxic fumes even at room temperatures and would give off even more at cooking temperatures. Nontoxic white paint has reportedly been used for inner sides in place of foil. It is important that the white be as shiny and white as possible. Such ovens have generally cooked less well than similar foiled models. Ceramic paints so far have not performed well and give off odor for very long periods of time as well as performing poorly.

For trays and the outsides of pots, any dark color will produce heat better than any light color. Light-colored or bright pots reflect solar radiation away and so are slower to heat, or heat only from the hot air with little or no heat produced on the surface of the pot. Dark red, dark green, dark blue, and dark brown colors may be used. Paints on pots are best kept thin since thick paints insulate. On surfaces darkened by handicraft methods even "nontoxic" paints still may not be safe for ingesting so food should not be laid directly on a home-painted tray but needs to be cooked inside a pot or on a commercially dark tray. Paints that contain toxic solvents may be used ONLY IF THE TOXIC SOLVENT WILL BE COMPLETELY DRIVEN OFF BY PREHEATING. Determine this by using only commercial paints recommended for barbecue equipment or other specific food-related uses. Nontoxic homemade paints include children's non-toxic black paint powder, such as Tempera, soot from clean wood mixed with nontoxic water-based glue or soot mixed with cooking oil that smokes at low temperatures. High temperature cooking oils will remain sticky indefinitely but low temperature oils will become baked on.

Any new SBC is best heated initially for several hours without food to clear out any residual vapors. Some engine and conventional black paints never get over releasing heavy odors and will ruin an oven. If in doubt, run a preliminary test before risking any questionable paint.

Any EXTERIOR PAINTS or varnishes may be used to weather-proof the outside of the oven. The color of the outside does not affect oven temperatures if insulation is adequate.

Dark POTS with tight dark POT LIDS greatly speed solar cooking. There is a wide variety of potential equipment. Pots and lids of thin material heat faster than thick; metal faster than ceramic or earthenware except cast iron which is good but slow to heat initially; metal generally faster than glass; glass faster than gourds. All will make cooking equipment depending on availability. When darkening pots and lids, treat the outside only.

Occasionally it is fun to see the cooking. Lids may be left off of dark cakes, some cookies, corn chips with melting cheese, and a few other foods if desired. More moisture will condense on the oven glazing and the food will heat more slowly. Moisture condensing on the inside of the glazing may be wiped off intermittently with a clean soft cloth. If steaming persists and there is good sunlight, a small pebble or stick temporarily may be placed under the glazing frame or around the access door to open it slightly and allow moisture to vent. To reduce the condensation problem while still allowing full visibility, a small square of glass can be substituted for a lid. This is not recommended for routine cooking due to color changes which may indicate vitamin loss.

Foil is not generally recommended to wrap food for solar cooking, however, temporary pots or lids may be formed out of one layer of darkened foil in absence of any other equipment. Conventionally foil-wrapped food cooks very slowly if at all because shiny foil, particularly in multiple layers, insulates by reflecting sunlight and heat away.

Glass jars make good pots although they cook better if darkened rather than left clear. Also, darkening the outside of food containers will protect some of the B Vitamins. When painting the jars, a strip of masking tape placed from top to bottom before painting can be removed when the paint is dry to leave a tidy strip of clear glass for visual inspection of the inside.

Shiny pots or bread pans may be placed into brown paper bags or dark cloth bags to successfully cook without painting them. If using paper bags or cloths, heat them alone for several hours before

using them with food in order to drive off any unwanted vapors. Alternatively, a number of separate foods may be cooked in small, clear jars all under one dark tray or dark lid of a roasting pan.

When using jars for cooking, make a hole in the lid of any non-canning jar, such as mayonnaise jars, peanut butter jars, etc., to prevent steam buildup. Dome and ring canning jar lids that are designed for food preservation automatically release excess steam pressure yet are safe only when used on canning strength, food preservation jars. The thickness and strength of non-canning glass jars is not intended to take the strain of steam under pressure and could break explosively unless vented.

Some low-fired earthenware pots do not initially cook well although dark colored, hard-fired earthenware pots with glazing work very well. Perhaps the poor performance of some earthenware is due to liquid soaking through and evaporating on the outside, or perhaps it is due to the thickness and porous nature of low-fired clay pot sides. Experimentally, in the efforts to use low-fired, unglazed earthenware, the goal has been to approximate the hard-fired pots by filling the pores and to providing a form of glazing. On a homecraft basis, this has been done by saturating the pot with food-type oil, fat or natural resin which both closes the pores and changes the surface. Oil also will conduct heat rather well and this may be part of what improves cooking in low-fired, earthenware pots following oil treatment. Light colored earthenware needs to be darkened on the outside only, perhaps by rubbing a dark food, nontoxic dark powder or soot from clean wood into the oil coating. Even so, there may be forms of low fired earthenware that are difficult to use for SBCs.

Gourds to be used as pots need to be fully ripened, scraped and cleaned to a thin hard shell and, if of a light-skin variety, need to be darkened on the outside. Gourds almost completely filled with food cooked better than gourds with a little food in the bottom. Experimentally, like with low-fired earthenware, treating inside and outside surfaces with vegetable oil or animal fat seems to improve the cooking times. Low temperature oils which scorch to a useful dark brown are olive oil, used lard, and peanut oil. The point at which oils will darken can be lowered by utilizing old oil that has been used for cooking, perhaps which still has food particle in it, or which has an added emulsifier.

The Santa Domingo gourds tested were kept sitting upright while they grew. After harvest, they were dried outdoors in the shade for some months until the seeds begin to rattle. Then the tops were cut off and the seeds and inner pulp removed. They were scraped to a hard surface inside and out. Our test gourds held between 1 and 1.5 quarts (.95 and 1.4 liters) and after preparing as pots were almost spherical with 3 inch (7.5 cm) openings. The sides were approximately 1/8 inch thick (.3 cm).They held liquids, did not flavor the food and produced cooked food over a period of many weeks. Heat seemed to penetrate slowly. Gourds cooked faster with lids made of a small squares of clear glass rather than dark lids, which sacrificed some level of B Vitamins in some foods. This was judged to be a minor effect compared to the convenience of being able to grow your own solar pots in some cases.

On an experimental basis, where very large gourds are available their shells might be evaluated for use as inner boxes. If they proved successful, used in conjunction with gourd pots in an insulated pit or other outer insulation, the materials needs for low temperature SBCs in equatorial regions might be reduced to simply foil for the inner surface of the large gourd and the glazing...or perhaps

to only the glazing? This is highly speculative and cannot be appropriately evaluated at 34.4 N. Latitude where our work is done.

POT LIDS can be HOMEMADE by turning the pot upside down on a flattened piece of metal and drawing an outline. Cut the metal about ¼ inch (.6 cm) outside the line. File or sand the sharp edges to dull the cut surfaces and protect the fingers. This may be done simply by rubbing a rock along the cuts. Working regularly around the lid piece with pliers, bend the edge down at the line. Sometimes the fluting looks nice. If necessary, cut from the edge into the line to allow the pieces of edge to overlap. Darken the outside of the lid and heat it for several hours before using it with food. Temporary lids made be made by the same method using a brown paper bag and creasing the paper at the line. These also need to be heated alone for several hours before being used with food. Sometimes small holes are punched in a lid to allow moisture to escape and produce a drier crust on foods such as breads or breadcrumb toppings, cakes and cookies.

Nutritional research in great detail has been done by Professor George Hammons and others at Philander Smith College in Little Rock, Arkansas, USA. After analysis of many different nutrients in food cooked equal times by conventional methods and by solar box cookers using dark pots with lids they concluded that solar cooked foods retained nutrition as well as or better than foods cooked by conventional methods in spite of the longer cooking times required.

Small pieces of glass may serve as lids on many different pots, as mentioned previously. The question as to how much vitamin loss occurs when food is cooked without a pot lid or under clear glass needs to be researched. Judging from color changes, there may be some vitamin or nutrient change if food is exposed to bright sunlight while cooking. This may be more important when cooking liquids than when cooking solids, since liquids will circulate by convective flow exposing a greater proportion of the food to the sunlit edges. Riboflavin, a major B vitamin destroyed by light, is found in milk and milk products, eggs, liver, kidney, grass, fruits, leafy vegetables, yeast, etc. These foods with light-sensitive vitamins definitely should be cooked in dark containers.

Research is still needed comparing the effects of solar cooking with food exposed to the sunlight after it has passed through various layers of glazing with solar cooked food using lids. Research is also needed on whether or not there are significant amounts of aluminum compounds absorbed into the food from aluminum pots when foods, particularly acid foods, are cooked at the relatively low temperatures for extended periods of time typical of solar box cooking. Until the facts are established, foods should be cooked with dark covers and aluminum pots not be used unless no other pots are available. Also, there are unresolved questions at this time about the possible uptake of metal compounds into food cooked in tin cans.

TRAYS used for the heat absorber on the bottom of the solar oven need to be dark, almost cover the bottom, and support the weight of pots and food. Ideally, they should contain any liquids that might spill and be removable for cleaning. Within this range there is great variation and all the criteria are sometimes not met. Lightweight, darkened or enameled metal trays are usual and may be made of steel or aluminum. Recycled, dark-enamel conventional oven trays have been utilized successfully. Dark cookie sheets, if the proper size, will work well. Moderately well-functioning SBC trays have been made with soot-blackened cardboard trays.

Crafted trays can be formed by hand with the techniques used for making pot lids. Roofers' metal flashing or printers' "mistake" sheets make fine trays. After starting the bends with pliers, the rims

may be finished by hammering over a piece of wood with a square edge.

All trays need to be elevated slightly off the bottom of the oven. A University of Washington engineering study states that a thick tray will transfer heat to the pot more effectively than a thin one. This is particularly true when the tray is elevated above the foiled bottom.18 Field tests confirm these effects. If the hot metal tray is in direct contact with the foil on the bottom, heat will be conducted through the foil and into the bottom insulation. Thin wood strips, little pillars of cardboard, or narrow strips of cardboard glued into circles may be used to elevate the metal tray a bit (1/4 in., approx. 0.6 cm) above the bottom foil. With the tray floating in space on these small supports, there is a minimum of tray-to-oven contact and heat flows most readily into the cooler pots. Many successful solar cooks over many years have never done this, but it is one proven way to work toward higher oven temperatures where they are desirable.

GLUES and pastes must be nontoxic and odor-free when heated. Originally Elmer's White or Carpenter's Wood Glue was most used. Water-based and nontoxic, it is widely available in the U.S.A. Any nontoxic glue that continues to hold in the oven temperatures works. Most rubber glues are toxic; heat-melt glues will not hold.

Homemade paste or glue can be made from some grains or flours, such as wheat, rice or oats, and work particularly for attaching foil to cardboard. Laboratory tests have established that wheat paste has adhesive strength equal to or exceeding Elmer's White Glue. 18

Use a grain that makes thick sticky water when cooked. In the pastes tested the addition of about 1/8 part sugar or honey made some of them stick better. In Arizona, food glues which have dried are not edible to insects.

Cartilage from animal legs (the portion that ties muscle to bone, not hoof) can be boiled a long time and when hot spread for a durable hot glue useful on outer parts of the SBC. There are old references to fish glues but no record has yet come to me how that was done. Animal glues kept in a glass jar or tin can become soft enough to work when heated in an SBC. At the end of the work session, heating any of the organic glues or pastes in a container with a lid pasteurizes them so they are slower to spoil, particularly if they are then kept at low temperatures, like food. If using a non-canning jar, be sure to leave the lid loose until removing the jar from the SBC to relieve steam pressure.

If nontoxic, water-based glues or pastes are hard to obtain, consider taping, tying with spun fiber or bands of woven cloth, or stitching to hold the major pieces together.

This chapter, based on our experience to date, contains information to assist local designers. The creative mind of the local designer is by far the most important ingredient. To produce a large, insulated, glazed solar box cooker many different materials may be used in a new design, or any component may be changed according to the needs of the area and the designer. It is essential that new designs retain the fine cooking capabilities of the introductory models. In many, many areas around the globe through a friendly, harmonious relationship with natural forces and creative use of the materials readily available at hand, ordinary people familiar the background provided here can produce a major household appliance—a cookstove with free fuel delivered every sunny day.

CHAPTER 5

VARIATIONS

In designing solar box cookers for a variety of uses in different locations, the primary changes will be in the application of different materials and skills, rather than major changes in the time-tested basic design components. Cardboard, the preferred material for our portable cooking and teaching model, may not be suitable for many locations. The major Kerr-Cole designs have been based on use of cardboard, foil and crushed newspapers because they are easily available where we have done our work, environmentally sustainable and because they work well. In other areas, other materials may be more appropriate.

Each material has its own characteristics and design challenges. For instance, in using metal sidings, care must be taken to assure heat is not drawn out of the oven by a thermal bridge forming a radiator. In using basketry, care must be taken either to weave tightly or line the inner and outer units so air cannot penetrate or heat escape. This is part of the challenge for experimental designers...to use what is locally available to produce an SBC design that will function as needed.

The broad, shallow, well-insulted cavity with a dark bottom, the approximate size, the relatively large, glazed window, and in most areas of the world, the adjustable reflector must be maintained.

These solar box cooker components can be fabricated from any nontoxic material the craftworker chooses. In addition to being nontoxic, other material considerations include availability, minimal expense, ease of working, water resistance, cost, durability and weight. Different SBCs that are beautiful, functional and convenient can be produced all over the world using traditional construction methods with locally available materials.

Temperatures alone are deceptive because an SBC may or may not trap heat above, for example, 250 F (121 C) to 300 F (149 C). For some people, this sounds like a low temperature.

However, such SBCs can cook well. Under less than ideal conditions they are superior to designs based more exclusively on direct reflection since they use both direct and indirect solar radiation. A well-designed solar box oven will produce a larger, more even flow of heat and therefore deliver more cooked food than designs that rely more exclusively on reflection. Furthermore, many SBC cooks prefer 250 F (121 C) to 275 F (135 C) over 350 F (177 C) or above because the lower temperature ovens cook the food more gently and need less attention than higher temperature ovens.

Multiple reflector ovens that can reach 350 F (177 C) or higher and parabolic cookers which can even set fires utilize primarily direct solar radiation so their function drops more quickly than SBCs when clouds, haze, or pollution scatter the sunlight. Multiple reflector solar ovens and parabolic cookers present wind scoops that makes them liable to turn over in the wind. Also, a parabolic cooker may produce a point of high heat sufficient to fry and char food. Yet because the point of heat changes position so frequently as the sun moves, it requires a tracking device or frequent attention to refocus. The point focus has limited practical ability to produce multiple pots of cooked food. For most low temperature uses and particularly for cooking, the temperatures of a small focal point are not needed. Furthermore, the focal spot is a hazard as it can set materials on fire, or damage human tissue. Most parabolic designs are unstable in the wind and pots chill quickly in even moderate breezes. Few have the ability to retain heat through episodes of passing clouds. The most telling point perhaps is the extreme difficulty in producing an adequately curved

parabolic reflector and mount with simply techniques.

A good approach to designing a solar box cooker to meet local conditions is to become familiar with a standard SBC which is known to cook well at that location. Then, change those design elements that need to be modified to meet special needs or local conditions. And finally to run parallel tests between the new design and the standard to evaluated the comparative ability to cook.

All new designs need comparative tests. Cooking actual food in the quantities usually served is the best ultimate test of a solar box cooker. Cooking is the primary purpose of an SBC and cooking is a direct test of an oven's function. How long cooking takes is important. It may be equally important to evaluate how easy an oven is to use, can it be easily maintained or repaired, is it stable in the wind, can the children effectively and safely work with it, etc.?

PARALLEL COOKING TESTS can include the following:

Place identical small amounts (1/4 cup; 60 cc.) of a quick cooking grain, such as rice, with the usual proportion of water in similar small jars or darkened food tins covered with a small piece of glass, one container for each SBC in the test. Start cooking in the usual manner. Without opening the ovens, watch for grains to emerge from the water cooked, noting which SBC cooks the grain fastest, second, and so forth. Give each SBC an initial ranking.

Other parallel tests could include ability to handle large mass, such as considerable amounts of grain in earthenware or cast iron, and the ability to handle the variety of pots or trays of food needed for a complete meal. Some standard tests rank the ability to heat a specified quantity of water, such as 2 liters in a standardized pot.Tests should be run under full sun conditions, and also under semi-overcast and very weak sun to identify the designs' ability to utilize indirect solar radiation. Some tests should be run on windy and cold days; and some at very low sun angles, such as early or late in the day to simulate winter sun conditions.

Solar box cookers are a very "forgiving" technology. They do not have to be perfect, nor optimized in every respect to serve well. A practical, useful goal is to make designs that will cook absolutely the most conveniently possible, given what the designer has available and needs of the users and the types of cooking to be done.

The evolution of the basic SBC concepts to many different designs serving a variety of needs and cultural norms will dramatically increase the application of this simple technology to pressing food and environmental problems.

EXAMPLES OF SPECIAL DESIGNS

- For an arthritic friend, one SBC was raised on a waist-high frame with large wheels so she could move it easily. At that time, in the mid-1970s, we were not aware of any safe, lightweight plastic glazings to use. Since the glass and frame were too heavy for her to lift, her top framing was extended to one side. This extension made a push cart of her solar box cooker. Tracks on the extension directed the window as she grabbed it with crippled hands and slid it to the side to put food in. This was quite successful and she cooked on it for years, taking pride in being part of the Solar Age.
- An inventive doctor adapted the SBC concepts to produce a vendor wagon. This was an

elaborate push cart, complete with cooking SBC, warming and holding SBC, cold box for storing additional supplies (an insulated box with insulated lid), a serving shelf, and adjustable sun umbrella. It made an attractive unit.

- Steve Tognoli has built a large oven (4’ by 5’ feet square (120 x 150 cm)) oven that is able to cook many pizzas at the same time. Its thick steel bottom tray preheats for several hours in the morning. This SBC was clearly constructed for this special purpose.
- Small SBCs, with inner ovens as small as 12 by 15 inches (30 by 40 cm), have been useful to cook for single individuals or warm small meals. Such small sized SBCs cook poorly in less than perfect weather.
- A solar pit cooker was made by digging a hole 3’ (90 cm) in the earth functioned as the outer box. There was no reflector. Twigs piled below the bottom of the SBC provided a place for water from storms to pond and drain without wetting the inner box. Pine needles both insulated and further supported the foil-lined inner box with darkened tray and two layers of glazing, one of glass and one of fiberglass. It cooked moderately well for 4 to 5 hours in the middle of the day at high sun angles at 34.4 N latitude, 5800 ft. (1740 m) altitude. For longer cooking hours, pots are placed along the west side in the morning and the east side during the afternoon. This form would clearly function even better at more equatorial locations. One adobe model seen in use on the Peruvian altiplano was lined with fiberglass ceiling insulation panels wrapped in aluminum foil.
- A number of different wooden models have been made. Some have padlocks used during cooking. Some have a door in one side, rather than a top opening. Some are integrated into a waist-high table form.
- In Lesotho, high in the central African mountains, they use two reflectors between high poles. The reflectors, mounted one above the other, both improve winter cooking and make their wooden unit very difficult to carry off.
- Some SBCs are formed with the sides solidly attached to the top and open by lifting the upper part of the oven off of the bottom. Some have a second, impact resistant glazing completely covering the top to make the unit rainproof.
- In an area of abundant, inexpensive hydroelectric power, a hot plate with thermostat set for 250 F (120 C) has been placed in a fireproof SBC design. Reports indicate satisfaction with this hybrid and that very little electricity is actually used due to their abundance of sunshine.
- In Kenya in a village where there was only one spot of sun, a large SBC was designed that had ten compartments. This could be moved as a unit, but individual compartments were used as separate ovens.
- In the Indian Himalayas, columns of adobe and dung have been built. The top is hollow and filled with rice hulls. In the center, a black metal "inner" box is buried. The top is covered with glass. There may be no reflector, but rain protection is essential. This design has been well accepted where it was introduced and detailed design instructions have been prepared by Didi Contractor of the Indo-German Dhauladhar Project.19
- One attractive SBC design folds into its lid and can be transported in its special carrying case slung over one shoulder like a very large purse. This design cooks quite well. Others have been designed small enough to be carry-on luggage for air travelers.14
- We are increasingly hearing of SBCs being placed on rooftops. So far there has not been any

mention of making any special rooftop design, however, a side or bottom opening access might be easier to handle than top access. All-weather SBCs might be utilized and in windy areas might even be bolted to a rotating surface which was firmly attached to the roof framing. There are also reports of cooking in the bed of trucks, and in times of no more than light winds on the tops and hoods of cars.

- Reports come from equatorial regions of cooking well without any reflector...a saving in material for those locations. If reflection from the side of a building or a window is falling on a sunny spot on the ground, that location might serve well for an SBC without its own reflector. Cardboard SBCs have been stored outdoors in a simple waterproof box. With an arrangement like this, cooking is usually done with the SBC sitting inside the bottom section of the wooden box. When a portable form is needed, the cardboard unit is taken from the wooden shell and transported to other locations. A cardboard SBC may also be stored under an enclosed table top or in a large, heavy duty trash bag thus gaining weather resistance while retaining maximum portability.

All of these were successful cookers. There are many potential variations. This flexibility is one major reason the solar box is a global solar design for solar cooking.

CHAPTER 6

SBC - A GLOBAL SOLAR FORM

The basic SBC—a large, flat-topped, insulated, glazed space with or without the single reflector—is so simple people often think, "So what's the big deal? Anybody could make one of those." That is music to my ears. The big deal is that these designs work! They cook! And they cook on free, widely distributed, abundant sunshine delivered automatically to the site. The SBC can quickly address a high-priority need in many locations—access to heat for cooking. These factors arouse enthusiasm and are the driving force of the spread of SBC technology. The simplicity of basic solar boxes leads to confidence and easy comprehension and is ideal for transfer of passive, low technology, solar energy usage across cultural and language barriers around the globe.

To maximize ease of such transfer and incidentally minimize the use of resources, the introductory design goals have been carefully refined. Following are the criteria of design that we have used:

The design is to be simple to comprehend and construct by people without extensive building skills.

Materials are to be widely available, as inexpensive as possible and easily substituted.

The cooker should use minimal Earth resources per unit and be maximally biodegradable ultimately, yet durable while in use.

All components within the cooking space are to be nontoxic at cooking temperatures following a brief initial seasoning by solar heat.

Construction is to require only minimal tools usually available in or around a home.

The cooker is to be capable of cooking a full meal for a large household or group within a

reasonable length of time, such as between sunrise and the midday meal, or between noon and sundown meanwhile requiring minimal attention.

The cooker is to be safe for people, including children—without danger of setting fire, producing blinding reflection, or causing a blister when touched on the outside. Safe for food—with little danger of upsetting or losing food.

The cooker is to cook quickly enough that there is no danger of food poisoning when correctly used.

These design goals have been met by the basic SBC designs developed by Kerr-Cole Solar Box Cookers and others working in the group of volunteers associate with that work.

Our basic design goals do not contain the targets of maximum collection of solar radiation, maximum production of heat, maximum thermal efficiency or maximum durability. These are incorporated to the degree possible as secondary design goals. Our basic introductory SBCs are tailored to be obtainable independently, individually, and under adverse conditions such as lack of money, lack of market outlet, lack of advanced knowledge, lack of government or other organizational support or in emergencies.

Herein lie some of the special characteristics that have made current solar box cooking efforts acceptable on a wide scale, cross-culturally, where previous solar cooking efforts have not been self-sustaining. It is delightfully empowering to construct a major labor-saving, home appliance by one's own initiative and effort. It is within the grasp of vast numbers of people who, independently, can handicraft, use and maintain their own SBC. If it is to be mass-produced, ideally manufacturing would be done as local industry, in small businesses close to the point of sale and still using locally available labor and biodegradable materials.

Reasons for DESIGN CHOICES include the following:

The BOX FORM is familiar, lowering the emotional challenge of putting food into an SBC as opposed to more unusual designs. It looks simple, often homey—yet it can be made in a beautifully artistic way by skilled workers through careful detail work and personal decorating. This is an extremely important factor.

The BOX FORM can easily be adapted to many other uses for low tech passive solar heating such as greenhouses, water heaters, pasteurizers, or incubators, and so it is a good form for basic solar education.

The SINGLE REFLECTOR/LID, in addition to requiring little material, is simpler to build and requires less reflective material than the multiple reflectors or curved reflectors required by some cookers. Yet it provides adequate heat for cooking and protection for the glazing during transport and storage.

The single flat reflector minimizes wind resistance. When combined with the heavy, broad oven base, the unit resists overturning by wind. It allows maximum sun without shadow from the side as the sun passes.

The FLAT TOP is simpler to build for many people than a sloping or beveled top. It allows the inner oven bottom to be fully used as the entire oven is the same depth. Also, heat that stratifies in

the upper level is held down over the top of pots by the flat top. While the flat top is particularly well suited to areas close to the equator where 60 or more maximum sun angles occur most of the year, it continues to function quite far from the equator, at least as far as the 50 latitudes.

The flat top stacks and stores well and can double for other functions such as a small table or a box for transporting food and pots.

The LARGE COOKING AREA allows several regular size pots to cook simultaneously, closely matching the meal pattern in many parts of the world.

The LARGE GLAZED AREA, the transparent window, collects both direct and indirect radiation allowing cooking under somewhat overcast conditions if necessary.

SBCs CANNOT SET FIRE to anything since they never reach minimal ignition temperatures. With no intensely concentrated hot spot, they are also safer for eyes, particular the eyes of malnourished individuals or children. Foil reflection is functionally bright, yet not blinding.

Using the design factors and the basic heat principles experienced with the introductory SBC, the COMPONENTS CAN BE CHANGED within logical limits to meet local preferences, such as a basketry, quilted or a wooden exterior. For instance, perhaps some designers will deliberately sacrifice use of the early morning and late afternoon sunshine, and build a local SBC without a reflector in an equatorial region in order to save on materials. In such case, they will know that the protection of the glass by the lid will be sacrificed unless a non-reflective top is provided.

Utilizing practical knowledge and experience gained through making and cooking in the introductory basic SBC, the designing of other glazed, well insulated heat traps is expedited. SBC technology is going forward to function in shapes and materials familiar to each area.

The Kerr-Cole SBC EcoCooker design has been the backbone of American solar box cooker global outreach. Made of cardboard, it was especially developed as a lightweight, portable, teaching and cooking demonstration tool. The EcoCooker kit provides pieces that can be assembled to provide a good teaching and cooking model and that can be used as patterns to cut pieces for more cardboard SBCs perhaps out of recycled materials. It can also be used to discuss the components needed for a successful SBC made of more weatherproof or locally available materials. Finally, it has been used as a convincer to prove that the simple box design will successfully solve a major domestic problem around the globe.

Multiple lines of approach to building SBCs are developing. Some of these current efforts are working are toward even lighter weight, smaller sizes while retaining optimum cooking capacity, collapsible models for easier transporting, and some SBCs using even less material. These also serve as models for SBCs that can be made of many other substances.

A great many SBC designs will probably not be made of cardboard. There may need to be a large number of variations of SBCs even within the same country, depending on the materials, skills and traditions of each area. It is important that adaptations be formulated to meet the needs of varying localities. Experimental research is best done by far-sighted, knowledgeable members of the group who will use the resulting SBC, or at least with their close cooperation.

Within the United States there are at least four small commercial efforts producing SBCs based on

outer shells of wood, metal, fiberglass or plaster. There are also innumerable designs with cardboard as the primary material. These varied efforts all incorporate the relatively large, adequately insulated heat trap oven with a flat, broad base accommodating multiple cooking vessels and utilizing a combination of direct, indirect, and reflected sunlight.

At present the tendency seems to be toward accepting lower oven temperatures than were initially felt to be essential. In fact, food will cook in ovens that only reach 220 F to 250 F although ovens that reach 300 F or higher handle more food and cook faster. Much above 300 F, an oven loses the ability to cook food without charring or overcooking it and so require amounts of attention and precision not necessary for SBCs within the range from 220 F to 300 F.

As the basic concepts of the solar box cooker are adapted to different cultural, artistic and craft traditions, some of the design changes will affect the cooking function. A standard SBC may be used for parallel cooking tests to check on the changes being incorporated, and to establish optimum local forms without inadvertently losing cooking effectiveness.

When SBCs are introduced into a culture, local endorsements, as well as religious ceremonies and blessings, should be respectfully utilized where it is appropriate. Of course, local colors and pictorial decorations for the outside as well as local material for construction of the SBC should be encouraged.

CHAPTER 7

NON-COOKING USES

In addition to cooking, solar boxes and the principles learned through cooking in a solar box cooker may be used for many other home and commercial heating purposes. Sometimes the SBC used for cooking regular meals can be used for the alternate use. But sometimes it is better to build a separate SBC or an adapted solar box for a special purpose.

PASTEURIZATION of water and milk are by far the most important non-cooking uses of solar box cookers. Pasteurization kills microbiological life such as viruses including rotoviruses, bacteria, cysts, flukes, worms, eggs, and other living contaminants. Use of an SBC does not remove toxic substances such as heavy metal or mineral salts, radioactive particles, pesticides, most chemicals or other non-living contaminants of water.

Careful scientific studies have documented that water can be pasteurized in an SBC. It has also been established that temperatures required for milk pasteurization can easily be obtained. "Heating water in an SBC to at least 65 C (149 F) ensures that the water will be above the milk pasteurization temperature of 62.8 C (145 F) for at least an hour, which appears sufficient to pasteurize contaminated water." If the temperature reaches 71.1 C (160 F), milk is pasteurized in 15 seconds.

These studies were performed with 3.7-liter jugs (gallon jugs). They also state "On clear or partly cloudy days, with the SBC facing magnetic south in Sacramento, (California, USA, 38.5 N. Latitude, low altitude), bottom water temperatures of at least 65 C could be obtained in 11.1 liters (2.9 gallons) of water during the 6 weeks on either side of the summer solstice." They were using a fixed southern focus and fixed perpendicular reflector. Reduced quantities could be pasteurized at

the beginning and end of their solar season. And "Periodic repositioning of the SBC towards the sun, adjusting the back reflective lid, and preheating water in a simple reflective device increased final water temperatures. Simultaneous cooking and heating water to pasteurizing temperatures was possible. Additional uses of the SBC to pasteurize soil and to microbiologically decontaminate hospital materials before disposal in remote areas are suggested."4

Sacramento is out of the sun belt and has approximately a seven-month solar season. Areas with higher sun angles will get proportionately better pasteurization results and may be able to use these techniques throughout the year. Also pasteurization may be continued during the off-season by processing lesser amounts or using smaller containers. Integrating this scientific information into a household routine has led to some other adaptations.

HOUSEHOLD PASTEURIZATION is particularly valuable. Pasteurize by placing the fluid in dark pots with dark lids, or in darkened or clear gallon jugs or in quart and pint jars with rubber seals so it is available in individual portable form. As mentioned before, Riboflavin, an important B vitamin in milk, is destroyed by light. Therefore, dark jars or covered pots are best for milk whereas water with a little extra time may be processed in clear glass on a dark tray in an SBC in full sunlight. To process by the gallon, an especially deep solar box cooker is constructed.

To avoid permanently darkening glass jars, unpainted jars may be set in the SBC and then covered with a dark, navy blue or black, cotton cloth. Another alternative is for clear jars to be placed within a dark lidded pot. These methods heat fluids more slowly than painted jars exposed in the sunlit oven.

Food preservation canning jars with dome lids and rings are safe in an SBC; non-canning jars are not safe if the lids are closed tightly since they do not release steam automatically and are not structurally designed to withstand pressure. Steam may build up and NON-CANNING JARS MAY EXPLODE IF LIDS ARE ON TIGHT or are not vented with holes in the lids.

Canning jars using dome lids and rings may be sealed tightly during the entire run. If using vented lids for processing, place a set of solid lids in the SBC during the run and use them to seal the jars as they are removed from the SBC. Place jars in the solar box cooker with space between each jar and focus as for cooking. Pasteurization has occurred when the temperature in the water or milk at the bottom of one container near the equatorial wall of the SBC reaches 149 F (65 C) or when the wax in a temperature indicator melts and runs to the bottom of its space. If a thermometer or other heat sensing equipment is not available, heat well beyond the point where bubbles appear, until bubbles are rising steadily in a gentle boil.

When pasteurization has occurred, seal the lids on non-canning jars as they are removed from the SBC. Pasteurized sealed jugs and jars of water may be cooled and stored prior to use, ready to grab and go, providing safe drinking water throughout the day. Pasteurized milk should be cooled immediately, stored in a cool area preferably below 50 F (10 C). With cool storage, pasteurized milk will keep up to a week or longer. Milk can be pasteurized and then incubated with yogurt culture until it thickens. Yogurt and buttermilk keep longer than plain milk and so are particularly useful in households without cold storage.

If a full run is not needed, two or three pint or quart glass jars of water or milk placed in an SBC after food has reached cooking temperature will be pasteurized without interfering with cooking.

If the water tastes bad, a small amount of organic citrus peel, fruit juice, vinegar, or other acid flavoring may be added to the water prior to pasteurization.

This pasteurization information relates only to water and milk. Food, sauces and juices cooked in an SBC should be handled for food safety like the same foods cooked by one's conventional fuel. For Food Safety see Chapter 2 on Basic Theory.

SOLAR DRIED FOODS in small quantities can be prepared with an SBC but solar box cookers do not make efficient food driers. There are solar designs specifically for drying food which are far superior to adapting a solar box cooker for this purpose. Because an SBC is tightly closed, water vapor cannot easily escape. In addition, even if the lid is partially open it is very easy to get the SBC too hot and cook food instead of drying it. Using the box section and a reflective lid without glazing or simply not using a lid may be tried experimentally. Also, small quantities of food may be dried on the top glazing on a rack.

Both of the above methods may provide some protection from insects. In Arizona, flies, wasps and other insects avoid going into the very bright light thrown by reflectors. This method has not been tested where there is a severe fly or other insect problem. Experimentally, fish, meat or other food might be dried either with a lidless solar box, or in front of a large corner-shaped reflector like the simple water warmer. (See Page 72, Diagram 11).

INFESTATIONS IN GRAINS AND DRIED FOODS can be killed by heat. Grains or dried foods infested with weevils and other insect larva can be spread in a one half-inch (1.2 cm) deep layer on a tray. Place tray in a preheated SBC. Leave for 10 minutes, stir food, and leave for another 10 minutes. Cool and store securely. Check in a few days to be sure the infestation is completely gone.If necessary, a second treatment may be given using longer times.If dried foods have obviously been contaminated by insects, heat treat them just prior to storage even though no larvae or weevils are yet visible. It will kill the eggs. SBC heat treatment also halts mildew and mold in stored foods.

Natural wool fleece, yarn or cloth can be heat treated up to 150 F (65.5 C) without apparently damaging its strength, color or durability. This should either be done in a very large SBC, or in batches small enough so that the heat penetrates to the very core and bottom of the material.

SOLAR FOOD PRESERVATION (CANNING) is safe only for ACID FOODS. Acid foods are fruits, fruit juices, jellies, jams and sauces, sour tomatoes, and most pickles...those foods which can be processed conventionally in a boiling water bath. Hot air in an SBC functions similarly to water in a boiling water bath. There were problems with hot air canning in the past due probably to the fact that conventional ovens have not held an overall uniform temperature, so food in cooler spots in ovens was not fully processed. Also temperatures drop before a thermostat clicks on. With the steady temperature in an SBC there are no seriously cold spots and many food preservation runs of acid foods processed in the following manner have been kept for months and years in good condition.

Food selection, preparation, syrups, and times are identical to those used in good food preservation and canning manuals. The way to achieve these are adapted to the special characteristics of SBCs. Hot packing after stewing the fruit in a dark pot makes a fuller packed jar as air has been driven off and the fibers softened. However, cold packed food also keeps well. Preferably use commercial

jars with dome lids and rings as these can be sealed prior to processing in an SBC.

To preserve acid foods, use a good food preservation or canning manual for basic instructions. Prepare the food, pack the jars adding hot or cold water or syrup to complete the fill, place a moistened dome lid on top and tighten the ring. Place the jars on the dark tray in an SBC with at least ½ inch (0.6 cm) space between jars. As with pasteurization, clear jars may be used if covered with a dark cloth or placed within a large lidded dark pot. Focus the SBC and allow preheating. During preheating the dome lids are steamed and jar contents are heated, exhausting internal air from the food. When oven temperature has returned to 225 F (107 C), timing starts. To allow a safe margin, oven is usually held above 225 F (107 C). It is crucial that the air temperature in the SBC not drop below boiling during the time of processing. Use the regular times given in a good standard manual for boiling water bath treatment. The SBC temperature may rise further without harm but if the temperature drops below 212 F (100 C) timing should be started over if the temperature recovers or the batch run again next day.

If there is no thermometer or timing is not possible, allow jars to remain in the SBC until one actively boils or runs over. This indicates that food temperatures well above the minimum needed for safe canning of acid foods have been reached. Take out the whole run. Immediately seal any non-canning jars, but do not further tighten rings on dome lids.

Follow clean, careful methods when preserving, storing and using foods. As with conventionally canned foods, carefully check stored foods before tasting any amount, however small. Canned or preserved goods, either commercial or home processed, should be clean looking, clear of any mold or bubbling, lid should be on securely until deliberately removed, there should be no spurting pressure when food is opened, and the odor, both when cold and after warming, should be good. At any hint of foul smell or questionable condition, food should be discarded without tasting it. Discard by burying deeply, below animal level. Safety in the use of techniques in this book is the responsibility of the SBC user.

Solar box cookers CANNOT preserve most vegetables, meat, fish, grains, or other low-acid foods. They are better stored after pickling, salting, or drying. To be kept in a moist condition, PRESERVING NON-ACID AND LOW-ACID FOODS REQUIRES THE HIGHER TEMPERATURES OBTAINABLE ONLY BY PRESSURIZED STEAM to kill all the spores of organisms that spoil them. The problem with non-acid and low acid foods is that spores not killed by boiling water temperatures can sustain bacterial growth and toxin production within the cool, processed food. Some non-acid food spoilage, such as botulism is fatal in very small quantities. Never taste questionable food.

EVAPORATION of juices into syrups, and pureed fruits into fruit butter, as well as thickening watery maple syrup, etc., gives good quality food if processed in glass, enameled steel, or stainless steel. Place food for evaporation in a shallow pan in solar box cooker. Glass jars can also be used, but they evaporate much slower than a shallow pan. When food is steaming, set the pot lid off and raise the SBC lid slightly with a small pebble or stick. Evaporation takes place slowly but little attention is required.

For SANITIZED DISHES, scalding hot rinsing water is unnecessary if an SBC is used to heat the clean dishes after they are washed and rinsed. This treatment is much quicker than heating rinse water. Pasteurizing temperature can be estimated by heating until the center of the dish stack is too

hot to touch. By that time the forks and spoons as well as small drinking vessels which have had mouth contact are quite hot. For washing, water can be heated to a comfortable level in a dark container simply set in the sun. For temperatures up to perhaps 120 F (49 C) set the dark container in the corner of three-sided, foiled water warmer. (See Page 72, Diagram 11).

DRYING SMALL FUELWOOD, tinder and bundles of kindling can be done any time the SBC is not in use for cooking. If very much condensation occurs, leave the lid slightly open to allow moisture to escape. Solar drying rather quickly makes tinder and kindling easier to light. Drying heavier wood, such as logs, is a slow process but considered by some to be worth it because more heat and less smoke results when dry wood is burned than when it is green or damp. Split logs dry faster than solid logs because of the open cut.

There are solar designs specifically for drying of wood depending on the sizes and volume to be processed. These might also be tried experimentally for drying dung. Solar fuel dryers are different from SBCs. As examples, a solar fuel box may be constructed without insulation...just a box, with top glazing. Large air vents are arranged at the top and bottom with the openings protected from driving rains. Sometimes the wood dryers are big sheds with glazing on top and on the side facing the equator. Some designs have heat concentrating troughs that lead hot air into the shed section. A very large flow of hot, dry air through the wood stacks is essential. This is a special field and worthy of study if there is much need for drying of wood or other large amounts of agricultural mass.

INCUBATION may be speeded by providing a warm growing area in a solar box cooker. Batches of yeast dough or yogurt are relatively simple. Incubation requires low steady temperatures comfortably warm to the hand, (105 to 115 F or 40.5 to 46 C). While solar cooking in an SBC usually cannot be done indoors, because of the low temperatures required an SBC being used as an incubator can be placed inside at a sunny window. A solar box used as an incubator may be smaller than a regular cooking SBC or a standard SBC may be used. Closed overnight, a warm SBC provides many extra hours at growing temperatures.

Incubation is easier to handle with additional mass. The mass to store heat may be jars of water, rocks, bricks or other heavy clean weight. For most purposes, the temperatures are raised to the top of the range and then allowed to fall slowly until another boost is needed. With experience, the glazing can be masked just sufficiently to provide the level of heat needed without overheating.

SPROUTING of seeds for food or garden is speeded by utilizing an SBC to provide a warm, protected growing area. Standard instructions for sprouting should be followed. Where water is contaminated, sprouted seeds and grains to be used for food can be rinsed with SBC pasteurized water. Jars and sprouting equipment can be pasteurized by SBC heat, using the same process as for dishes. Do not heat treat the seeds as this will kill them.

YEAST for bread dough thrives in a warmed SBC. The mixed dough can be placed in a warmed SBC for each rising period. Although additional mass and insulating cushions are not needed, their use provides more stable warming temperatures.

SBCs used as incubators should not SIMULTANEOUSLY BE USED FOR FOOD WARMING as food will spoil quickly at these temperatures. It has been established, however, that when SBCs are used for cooking, food passes quickly through the incubating temperature range and into levels

where bacteria are killed.3

COLD BOX: A closed SBC can be used to retain cold for several hours. This may be useful when transporting frozen foods, or ice. Protect the cardboard from drip water. In some locations night temperatures drop sufficiently to cool water, rocks or other mass which can then be put in an SBC to hold food at lower temperatures during the day.

PREPARED FOODS: Canned foods may be heated in the opened can. Frozen foods and foods for microwave cooking can be cooked in SBCs but heat faster when placed in a dark pot or at least covered with a dark lid. Any foil and foam trays should be removed before heating.

PREPARATION OF INFANT FORMULA: Breast milk straight from the mother is usually by far the best and safest food for a baby. However, when an infant must be fed from a bottle, the substitute milk or formula may be mixed in the regular manner, then given terminal pasteurization in a preheated SBC. Glass nursing bottles filled with the prescribed fluid, closed with nipples and tops, can be placed under a dark cover or in a preheated dark pot with a lid in an SBC. Since riboflavin, an important B vitamin, is destroyed by light, milk and formula should not be exposed to direct sunlight. Water and juice bottles can be placed directly on the tray even while the family food is cooking. As soon as they finish the prescribed time period or begin to gently boil, bottles should be removed and cooled.

BOILING DIAPERS: Non-chemical treatment of diapers and other soiled cloths to eliminate urine odor and reduce diaper rash is simple with an SBC. Wash and rinse well, wring out most of the water, and place in an SBC in a dark pot with lid. Steam will form, penetrating the fabric and killing the odor-forming bacteria. Rinse again, then hang out to dry. A separate SBC is recommended for this use.

HOT COMPRESSES: Place two sets of compresses in solution in a dark pot in an SBC. When solution has reached comfortable temperature, use compresses in rotation so one is heating while the other is in use. When treatment is completed, bring pot to a boil to pasteurize for next use.

MEDICAL EQUIPMENT customarily processed by boiling can also successfully be treated in an SBC. Put approximately one-fourth inch (.6 cm) of water in a dark pot with dark lid, add equipment, place in focused SBC. When heavy steaming occurs, start timing the run. Glass, metal and enameled equipment is safe; plastic equipment may or may not be melted by the heat. It is best to run individual pieces of plastic equipment until it is established which can take the steam, plus some additional heat directly from the pot lid. Some plastic respiratory equipment may be safely pasteurized only if completely submersed in water, which provides a cooler temperature than the steam, but requires a lot longer time to process. In general, steaming is better than boiling because it penetrates better. Also a little water plus equipment requires less time to heat than a full pot of water plus equipment.

MEDICAL WASTES—DECONTAMINATING: Soiled bandages and bedding, infectious body drainage, feces from intestinal diseases, and other infectious material may be placed directly in an SBC and thoroughly cooked to kill most infectious agents. How long it takes should be determined by specific circumstances. The SBC heat-treated materials will be disinfected although some heat-resistant spores may still be viable. A separate SBC is recommended for this use.

GARDENING: Potting soil can be pasteurized for greenhouses and special seedlings by placing

moderately dry soil in a dark can or dark pot with a lid and heating until a thermometer in the center near the bottom is 150 F (65.5 C). Ceramic pots can be washed and placed directly on the bottom of the SBC. Manure can be pasteurized easiest if it is light and dry.

Pots of seedlings can be incubated in a warmed SBC with the lid ajar for ventilation and to prevent overheating. Extra mass helps stabilize the temperature. As they get larger, the lid can be left off during the day and closed at night to prevent chilling. The foiled SBC oven sides provide extra light without too much heat unless the glazing is in place.

DECRYSTALLIZING HONEY AND MELTING BEESWAX:

Jars of crystallized honey can be placed in an SBC and gently warmed until honey is melted. It is best to watch that honey does not overheat and brown. If the cook is to be away, honey jars can be placed in a pot of water in the SBC. This will assure they will not burn, but it takes much longer than just warming the honey jars. If a three-sided reflector is available, that also works well for decrystalizing honey, yet cannot burn it.

COSMETIC WAX used for removing hair and removing fine cactus spines can be heated in an SBC without danger of flaming. Test to be sure it is not too hot for the skin.

ANIMAL FOOD can be prepared of cooked mixed grains, perhaps initially used as an extender for the animal's customary food, gradually shifting to predominantly solar cooked grains. Whole grains are standard animal foods and very inexpensive when purchased in raw, dry bulk form compared to commercial animal food. Flour mills and food cooperatives can be sources of bulk whole grains in quantities of 50 to 100 pounds. Dogs, cats and other animals need different amounts of fats and oils and other nutrients. Veterinarians or animal handling professionals can be approached for advice on the amount of oils and other non-grain components needed by a specific animal.

CHAPTER 8

THE EXPANDING WORLD OF SOLAR BOX COOKERS

As indicated throughout this book, our effort is concentrated on spreading knowledge of the simple ways of building efficient solar box cookers out of local materials. This includes handcrafting and small, garage-type industry employing local labor and materials to produce for local markets. The goal is that the 1.5 billion people who were suffering from a firewood shortage in 1987, and those added to that figure since then, know how to build and use their own SBC if they choose.

This appears to be a large and potentially profitable market. However, most of these people have little or no cash. Furthermore, there are not enough resources and stability in any organization, government or private, to supply solar cookers to meet the overwhelming need over time. To try to do so would seriously distort the economies. If funds were diverted to meet this need, supplies of other basic necessities of life would have to be reduced. Also, taking profits out of the areas where solar cooking is most desperately needed into the export trade would be to further the disaster. Even on the level of handcraft, it may take an entire month's income to get the limited supplies needed. Where the SBC is replacing the purchase of fuel, this is viewed as a bargain.

Mass production would, of course be cheaper, yet almost certainly would not place SBCs in the hands of the rural and poverty-level population on a sustained basis over the years throughout coming generations. The ability to build ones own SBC is a much more stable resource for the lowest economic levels.

Regular marketing is playing an increasing role in the SBC effort globally. There are several mass produced designs of solar box cookers currently on the market. SBCI, SBCN and others are also exploring this potential concentrating specifically on the design variations they want for teaching and technology transfer. It is important that any mass produced SBC be carefully tested to assure only good looking models that cook well are marketed. Otherwise, the market could be seriously set back.

Interestingly, in the years since the simple solar box cookers began to be taken seriously, they have predominantly been used by middle income, or artistic people in the U.S. and India. These are people willing and able to pay for what they see is desirable and this population to me represents an ethical marketing potential. Still,it is critical that the solar cooking field continue be built in sustainable ways whether an effort is targeted on handcraft or market production. And it is critical that many forces work together toward a growing acceptance of the technology.

In addition to our very active volunteer efforts aimed specifically at SBCs, other organizations with widely varying targets could help through making SBCs part of staff field equipment. They could provide training through their own staff, or through contracts with SBCI or SBCN. This could be done for budgetary reasons as a benefit to the organization or to the missionary as it would save on the costs of fuel for cooking and its transportation.

Perhaps more important, it is good public relations indicating members of the organization are serious about conserving the resources of the countries where they are serving. Use by NGOs and religious organizations would both add prestige to the SBCs and quickly expose the technology globally where it can be evaluated by local leaders. Where food is prepared for staff by local cooks, efforts can be made to encourage them to use the staff SBCs for a portion of their production.

Local community organizers and respected citizens who become familiar with the SBCs can reliably assess whether or not they would be valuable for their people. Political figures seeing SBCs working steadily over a period of time and understanding the value of substituting solar energy for vanishing fuel resources could lend their prestige to encourage acceptance.

We saw the effect of this combined approach at the first SBC workshop in Sierra Leone. Workshop leaders were told by the people, "We know of these stoves. We have seen the solar box cooker working before." They were eager to learn, knowing exactly what they were planning to do with the knowledge. Before the workshop was over, staff from the Institute for Agricultural Research in Njala had organized to "take solar box cookers to the families." It was several months before we discovered a Peace Corps worker had used and demonstrated an SBC showing her method of cooking her own meals as she moved around her assigned work. Among her observers had been members of the indigenous staff of the Institute who have a reputation for genuine concern for their people. When the Institute staff took SBCs into villages and demonstrated them, their people knew it was a legitimate and valuable effort. Follow-up at 14 months revealed SBC activity and usage in Sierra Leone is expanding rapidly. In many ways this was an ideal

introduction and might serve as a pattern for other introductions.

Although the major organizations are valuable, meeting the need for SBCs is not totally dependent on successful official programs any more than on marketing ventures. It is not dependent on organized charitable or religious organizations. Any individual, acting alone or with others, can make a significant contribution to the spread of this technology. Many people on discovering SBCs not only use them for their own purposes; they immediately start an active effort to take their SBC around and show it to people who may be interested. This individual work is very valuable to the spread of SBC technology.

There is still a lot of potential market. A partial list of other marketing possibilities in addition to SBCs for routine cooking includes science education and home economics education kits, toys, lawn and poolside furniture, solar barbecues, equipment for developed campsites and picnic areas, garden equipment supplies, solar baby care units, as well as emergency equipment and supplies.

Vendor wagons could be manufactured and perhaps franchised. Restaurants might have solar hot bars on the patio particularly where Mexican and other southern food is featured. A gala solar flag could be flown whenever the solar bar was open.

While solar box cookers are often used simply for convenience and well-cooked tasty food, for recreation, and for environmental conservation within the United States, SBCs also can be used here to assist people in social stress. The stressed populations in the United States potentially served by SBCs include individuals and groups who have inadequate income or those who do not have electricity and/or gas utility service including people who are transient or homeless. Unemployed or marginally employed individuals having trouble meeting bills but with access to a sunny area can reduce their costs by using SBCs for cooking.

Some disabled or retired individuals on fixed income could benefit. In the West Sacramento Senior Center, Bill and Thelma Rogers for years have helped clients of the center build their own SBCs. At this time, their workshops are booked full for months ahead. On some Fridays, these SBCs are brought back for a solar potluck. One afternoon, 34 individuals had returned with their SBCs and set them to cooking in the yard. While the program was in progress, one person lounged in the door, keeping an eye on the whole array. In the cool interior of the building, tables were decorated with balloons and flowers to add to the festive meal while recipes were tasted and compared.

Energy assistance offices could include instructions on building and using solar box cookers in the energy classes currently given to help control utility costs. Nutrition programs could provide knowledge of how to build and use an SBC for nutritional and tasty, inexpensive meals. For food distribution purposes, the solar box cooker is a cookstove.

Anyone can be important. Anyone using a solar box cooker, particularly using it for routine daily cooking, is participating in the most basic part of the effort. As friends, companions and neighbors see a solar box cooker working, they ask questions and become informed on a primary level. Whether or not they proceed to obtain one themselves, they become part of the informed population needed for a smaller percentage to adopt this new technology. The more visible SBCs are, the faster the technology will spread.

Individuals alone or with friends set up demonstrations at fairs, rodeos, picnic areas, educational meetings, environmental meetings, church gatherings, in parks, in poverty neighborhoods, on the

beach.... Some lend their SBCs for others to gain experience. Some take them as they travel in other countries. And all tell how they can be made and used through one's own efforts. Individual friends in numbers much too large to list have done this spontaneously and voluntarily. Their activities are so individual that we meet friends who tell us they have been using them for their household cooking as well as actively and devotedly showing their SBC over the years but never thought to write and tell us. There is simply no count of these numbers. We do know that we are encountering more and more Americans who have awareness of the effectiveness of SBCs, and perhaps have even used one at their home for a long time.

Some travelers are carrying a roll of foil and SBC literature with instructions how to build an SBC in their luggage. Some also carry a supply of food-safe baking bags for glazing. Part of their vacation is spent building and showing SBCs, using one, leaving one as guest gifts, etc. The efforts they have to go through to locate sources of recycled cardboard or appropriate siding, glue, glass or glazing, and so forth, not only introduces them to a number of potential friends, it proves unequivocally that materials are available in that place for others to make SBCs after they have gone. If there are problems with obtaining foil, sometimes an organization can be located that will have other volunteers as they come from the States bring a roll. Shipping into many areas does not get through and requires dealing with border problems not aroused by single rolls carried as personal baggage. The most economical source of large rolls of foil is either food catering businesses or the aluminum wholesale centers.

Use of SBCs in science classes and home economics classes in primary and secondary schools is another method of technology spread. Independently teachers in two Montessori schools, one in Sedona, Arizona, USA, and in one in Lesotho, South Africa, have had primary school children using SBCs to heat their lunches. In Sedona, the students first made their own wooden cooker and then began to use it on a regular basis several years ago. SBCs are often used for science projects. In El Paso over 400 SBCs were made in one year through the efforts of one individual working through the schools. In the Sacramento area, an SBC project resulted in 70 SBCs lined up outside a school one day...each student had decided to make one individually and take it home.

Small or remote public health facilities could reduce costs by providing staff lunches through using an SBC while simultaneously and continuously exhibiting the potential to people attending clinics. A separate SBC could be used to pasteurize equipment by boiling or steaming. And perhaps a third SBC to disinfect contaminated equipment and materials.

A new stage of technology diffusion is reached when someone asks how they can make an SBC, obtain an SBC, or where they can get help developing an outreach program, etc. At that point the choice arises whether to hand out literature, refer them to SBCI/SBCN, or to personally sponsor and hold a workshop. Both SBCI and SBCN will mail single copies of their newsletter on request. Very good literature to hand out is available in bulk. Materials including videos to assist workshop leaders are available. Personnel of SBCI are also prepared to work closely with any organization ready to explore integrating solar box cookers into their programs. All levels of involvement are valuable contributions to the effort.

In Zimbabwe, workshop leaders from SBCI found that based on the SBCI material obtained in advance, many SBCs had been made and were working prior to the workshop. Workshop leaders were able to build on considerable knowledge in the people they were training. Some workshops

based solely on material mailed out by SBCN are being held in Ecuador. This established that the materials sent out by SBCI and SBCN, as well as Kerr-Cole Enterprises, are in fact crossing cultural barriers and resulting in local SBC production.

In Central America, at a workshop in El Progresso, Guatemala, leaders from Nicaragua also attended. One returned to Nicaragua where he was asked to train a group of community leaders from Honduras. The Hondurans returned to teach their own people. Also in Central America, at one time SBC volunteers were advised not to attempt to cross a certain military line as it would be too dangerous. But they were told that if a workshop were set up near the border, a group would come out and learn to make Estufa Solar. Asked why it was worth the danger involved, the reply was that their families were getting blown up by land mines while gathering firewood. SBCs would make their families safer.

There are endless opportunities until SBCs are as familiar as wood fires or campfires and can be used where needed. The goal of spreading knowledge of solar box cookers around the globe, is overwhelming. Yet by people working together, it is happening. Some translations have now been collected by SBCI. SBCI also has some language-free teaching materials. Sometimes they may already have a copy of a translation for a particular need or know where it can be obtained. It would be appreciated if, as new translations are done in the SBC field, a copy along with the specific language and dialect used and the area it is coming from, could be sent to SBCI for their file of translations.

Whether it is an organizational approach or a personal effort, all contribute to the spread of the technology. During the early years, the personal approach has dominated. This seems very fitting. For generations, new handicrafts have spread from people to people, through one person showing another a different homemade object. Often this has occurred through travelers. And through individuals trying for themselves how to make and use a way they see that would simplify their lives, or would add to their prestige, or in some desirable way meet their needs. We are less than 75 years in the United States into predominantly commercial production and marketing. In many places in the U.S. and in far greater numbers in some other parts of the world, traditions of handicraft, independent ways of meeting all one’s needs have not been left behind, simply obscured by the dominant culture.

Grassroots technology transfer has been the major distribution system for the solar box cooker effort, in part because it has spontaneously, naturally occurred. This distribution tactic, simple and effective over generations, fits the simplicity of solar box cookers. It allows a single individual, alone, to take an effective part in the technology diffusion as well as providing simple action targets for organizations. It answers the widespread, indigenous, desperate need. It allows completely individual choice of solar cooking and encourages individuals with initiative to make and use one. It makes solar box cookers an empowering technology. This part of the effort is very valuable and will continue. But grassroots diffusion is slow compared to the pace made possible by modern organizations.

Around the world, 1.5 billion people suffered from a shortage of firewood in 1987 and the number was rising rapidly. These people are part of our target population. We do not need to reach every village; but solar box cookers need to be seen in use in many parts of an area for widespread technology transfer to take place. The value of solar box cookers is recognized locally where they

are needed and appropriate. In addition, the value of solar cooking is recognized by major environmentalists. According to Lester Brown, Christopher Flavin and Sandra Postel of World Watch, one option for a sustainable future "is to turn directly to the sun, which most of the Third World has in abundance—solar ovens for cooking,...."

It has been calculated that if one person taught 20 people to make SBCs...and each of these taught 20 others...it would take only 7 "generations" to reach our initial turn-of-the-century target of 1.5 billion people informed about SBCs and knowledgeable enough to make one if need be. Of course, it does not proceed with mathematical precision, but the outreach is happening and seems to be gaining momentum. It is taking a long time. This process needs to be accelerated as much as possible so SBCs can be in use before complete exhaustion of firewood and dung gathering areas occurs.

Through marketing, through government, through private volunteer organizations, through churches and missions as well as overwhelmingly through individual efforts, solar box cooking has been quietly taking its place as one of the many tools for building an equitable, sustainable future where all have access to the means of meeting their basic needs and where the earth is treated gently.

In the expanding world of solar box cookers, the technology is mature. There is a depth of experience in the various uses. The literature is prepared. The basic SBC information and technology distribution organization is in place. Together with others who are working on the difficult environmental and human problems of these times, by consciously interweaving our efforts, we can all contribute toward building a sustainable future. Together, we have the power. Let us help you offer solar box cookers as part of the solution.

CHAPTER 9

A SAMPLING OF WAYS TO BUILD CARDBOARD SBCs

This chapter and the one that follows provide the practical material—a selection of plans for various cardboard SBC designs and instructions on how to use an SBC. The four designs illustrate different basic approaches to making successful solar box cookers out of cardboard.

The SBCI/ECO Design is a good statement of the oldest cardboard SBCs and comes directly from the original patent work.

The Adaptable Strip Design provides a basic pattern for producing new sizes and shapes, or for fitting a given box with a matching unit to form an SBC.

Designs by Mark Aalfs and Tom Sponheim both focus on using a minimum of material and time to make a functional oven. These quick designs fill the need for rough and ready building of an SBC, quick and cheap.

Which of these designs would best serve depends on the configuration of cardboard available and the amount of care and finish one wants to put into the building of an SBC.

Extrapolation to other materials should maintain the basic components: relatively large flat top, well insulated box, dark elevated tray, adjustable reflective lid, etc. For details of alternatives see

Chapter 4, Individual Design Elements. By studying these examples, the design of local variations in whatever material chosen will be made easier.

These plans may be duplicated and distributed freely. I hope they will serve you well.

AN ADJUSTABLE STRIP DESIGN

by Barbara Prosser Kerr.

This design utilizes cardboard or other thin, semirigid materials. Strips can be cut by a cardboard manufacturer or made by hand from pieces of recycled material or alternative local material taped or otherwise held together at fold lines.(See accompanying diagrams.) This design may be assembled as a solid or a collapsible unit suitable for general cooking, pasteurization, school science projects, or teaching purposes. When in doubt, make it bigger and broader, but as shallow as possible. This adaptable strip pattern may be used to fit an SBC to an available piece of glass or a section of the pattern used to tailor an inner box for an available outer shell, etc. It can also be used to fit a small SBC into a larger one for compact storage. The pattern and working diagrams for this design start on Page 70.

THE PROCESS

Establish the size of the inner box: For example, if the glass available is 24" x 20" (60 x 50 cm) and glass will extend ¾ of an inch (approximately 2 cm) beyond the window opening, subtract ¾ x 2 = 1.5" (2 x 2 = 4 cm). The measurements for the inner box in this example are 22.5" x 18.5" (56 x 46 cm). The length of the strip is the circumference -- 82" (205 cm). Another example: If there are three pots customarily used for meals, place them with about 1" (2.5 cm) between them. Set the size of the inner box to allow 1" (2.5 cm) between pots and inner oven wall.

Establish the insulating space you choose between the boxes:

Arbitrarily 1.5" (3.75 cm) in this example. Deeper insulation, up to 3" (7.5. cm), is used in SBCs with glass glazing in order to provide more protection than is needed for sheet plastic glazing.

Establish the size of the outer box: Take the dimension of the inner box and add twice the depth of the insulating space to the width of each panel. In this example, Panel A is 22.5 plus (1.5 x 2) = 25.5" wide. Panel B is 18.5 plus (1.5 x 2) = 21.5" wide. Therefore, the size of the outer box in this example will be 25.5" x 21.5" (63.75 cm by 53.75 cm) The length of the strip is the circumference -- 94" (235 cm).

Establish the depth of the sides of the inner box: Find the height of the largest pot to be used. Add 1" (2.5 cm) for the depth of the inner box. For example, if the tallest pot is 5.5" (13.75 cm), the depth of sides of inner box will be 6.5" (16.25 cm). For best cooking, make the inner box as shallow as possible.

Establish the depth of the sides of the outer box: Take the dimensions of the inner box and add 1" (2.5 cm). For this example, 6.5" plus 1" = 7.5" (16.25 cm + 2.5 = 18.75 cm).

Establish the depths of the bottom flaps: The depth of each bottom flap is one half the width of the adjoining panel plus fold allowance of approximately ¼" (0.6 cm) for single strength and 3/8" (0.9

cm) for double strength cardboard. Option—cut oversize, fold the box and trim the bottom segments so they just meet in the middle of the bottom of the box. For a lighter SBC, the bottom flaps on the B panels may be eliminated if the bottom joint is solidly sealed when SBC is constructed.

Decide whether or not to use the 2" tab to join the ends of each strip depending on the material being used.

For precision work, establish the fold allowance needed for your material: Measure 10" or 20 centimeters. Fold at each line to right angles. Note the inner and outer dimensions of the folded material. Use this factor to calculate measurements where space is critical. Most SBC work does not require this precision.

WHAT YOU WILL NEED

Cardboard from several boxes including two large flat pieces. Sizes depend on the dimensions you have chosen. It is essential that the cardboard is clean, smell fresh and never have been used for storing toxic substances. The two flat pieces make the lid and the reflector. The lid piece must be at least 3" (7.45 cm) larger all around than the finished size of the outer box and the reflector piece must be at least 2" (5 cm) larger in all directions than the finished lid. If you plan on a cardboard tray instead of a metal one, you need a piece for that too. (Option: any locally available semi-rigid, non-toxic material which retains its shape when hot and does not give off an odor can be used—stiff cloth, basketry, mats, leather, construction siding, wood paneling. If metal is used, see Fig. 4 on page 26 for heat breaks.

Regular kitchen aluminum foil—one 12" x 50’ roll. To calculate, take 2 x the circumference of inner and outer boxes + twice the longest outer panel (width of the reflector) plus 10% = 82 + 94 x 2 = 352" or 29.3’ plus 10% = 32.2’.(205 + 235 x 2 = 880 cm + 10% = 924 cm).

One ½" thick stick, approximately 18" (45 cm) long (the diagonal of the inner box).

Two pieces of stout non-slippery cord or shoe lace, 12" (30 cm) long.

One flat piece of metal the size of the inner box bottom, or a large dark cookie sheet, unless you plan to use a piece of darkened cardboard. A metal tray makes a hotter SBC than cardboard.

A small portions of a can of "barbecue black, high temperature resistant" spray paint. Must be non-toxic when dry. Options: Black tempera paint or a mixture of soot and glue or other non-toxic, heat resistant, darkening agent.

About 10’ (3 m) of duct tape. Option: Heavy cotton or wool cloth strips with heat-resistant, non-toxic glue or paste.

¾" masking tape, partial roll. Use of masking tape can be avoided by taking time for pieces to dry between construction steps.

Non-toxic, water-based white glue, 1 pint (0.5 l) Option: boiled white flour paste with sugar.

One Reynolds Oven Cooking Bag, large or turkey size. These are available in almost all supermarkets in the U.S. They are not UV resistant; thus they will become more brittle and opaque

over time and may need to be replaced after some months. Plastic options include polyester, polyethylene or plexiglass clear plastic sheet, as well as temperature resistant nylon. Polyvinyl plastics should be avoided. Single strength window glass may be used instead of plastic. Single strength glass does not need to be tempered. If it cracks, it can often be held in place with plastic tape or silicon sealant.

TO ASSEMBLE AS A STANDARD SBC, use these instructions as written. For a collapsible model, or for teaching and solar science projects see the variations listed at the end. These instructions will assume the SBC is being made in cardboard.

GENERAL INSTRUCTIONS

Working cardboard: Do not step or kneel on the cardboard unnecessarily. First make light marks to indicate the measurements. Then, using a straight edge and a dull pencil slanted at about a 60 degree angle (to keep from puncturing the cardboard), draw straight, firm fold lines. Bend the cardboard at the lines pressing over the edge of a table to make clean folds.

Working foil: Pour a small stream of glue on the dull side. With a small wet piece of cloth, smear the glue completely over the surface. Press onto the cardboard with a second larger piece of wet cloth and rinse off excess glue. After the surface has dried, the final cloud of glue may be washed off with clean cloths and fresh water. Foil needs to be clean and bright to work best.

Using the measurements you have established above for the size of the boxes, prepare the inner and outer strips of pieces of sturdy material. Where necessary, seal joints on both sides with tape or cloth. (See Page 70)

Measure the depths of each row of segments onto the strips:

insulating space between boxes, sides of boxes, bottom flaps. With a long straight edge, mark each row the full length of each strip with a blunt point sufficient to dent but not cut the cardboard. Bend the cardboard to loosen the folds. Do not mark and bend the collapsible fold unless planning for a collapsible model.

Cover the inside of each strip with kitchen weight foil glued on with diluted glue or paste.

With flaps extended and foil toward the inside, bring the ends of each strip together and secure by gluing or taping the end flap. Fold in and seal the bottom flaps of the inner box. (Diagram 2) Build pillars of 1" squares of cardboard the depth of the insulating space and glue them to the outside bottom of the inner box for support unless making a collapsible model. (Diagram 3)

To make the lid, turn the top flaps in on the outer box and place it upside down on the largest flat sheet of cardboard. (Diagram 4) Placing a pencil flat against the side of the box, draw the outer box outline on the flat sheet. Redraw with firm, straight lines. Measure out 3" (7.5 cm) and draw another set of lines. Trim to the outer line. Make one cut from the outer line to the inner line at each corner of the lid. Center the inner box upside down in the middle of the lid piece and draw its outline on the lid. (Diagram 5) Crease all the fold lines. Cut out the hole for the window. Fold down the edges to form a lip and bend the corner flaps around. (Diagram 6) Glue and tape the corners. Place the inner box inside the outer. Glue the top flaps of both boxes together unless making a collapsible. Turn upside down and weight to get good contact.

To make the reflector, place a long side of the lid on a straight edge of the cardboard. (Diagram 7) Working through the lid, mark that edge of the window. Draw an outline of the lid on the reflector piece. Measure 2" out and draw the cut line. Remove the lid and with a straight-edge, draw firm, straight lines through the edge mark and the outline. Bend the cardboard at the lines to make it flexible. This will form the hinge and start the turns for reinforcing the reflector.

Trim the overhanging cardboard to the 2" line. Trim the edges of only the narrow, hinge portion to fit the lid base. (Diagram 8) Fold the remaining 2" overhangs toward the outside of the reflector, cutting clearance at the corners so they lay flat and serve to reinforce edges of the reflector. Glue and tape.

Glaze the lid unless making a science project model. Plastic glazing would go on now. Depending on the size of your oven, either use an oven cooking bag whole, or cut it open. Working inside the lid, lay a strip of glue around the edge of the opening so there are no gaps where heat may escape. Lay the plastic over the opening and stretch it tightly holding with masking tape until glue sets. Masking tape alone will not hold the glazing when the oven gets hot. If better insulation is desired, attach a second piece of glazing on the other side of the cardboard using a narrow overlap of glazing where the reflector will attach so the reflector cardboard can adhere. If using glass, do not put it on now, but at the very last. See instructions near the end.

Paste foil smoothly on the reflector cardboard except for the hinge portion.

Centering the reflector on the basic lid, glue and tape the hinge solidly to the lid. If the assembly does not lay flat, weight it down until dry. (Diagram 9)

Working through the bottom flaps of the larger box, fill the insulation space with very loose non-toxic insulation such as crushed newspaper, rice hulls, loosely carded wool or quilt batting. With insulation, the air is as important as the fill so do not pack tightly. Close the bottom flaps of the outer box gluing shut for a permanent closure, taping shut with masking tape for temporary closure if the SBC is to be used for demonstrations or experiments. Options:

Demonstrators and collapsible boxes may also be closed with duct tape tabs. (Diagram 10)

Make the prop for the reflector. Cut the prop stick to the length of the diagonal of the inner oven so it can be stored in the oven. Midway along the side of the reflector and midway along the side of the lid, punch holes. Thread the cords through the holes and tie, leaving both ends free. These cords wrap around the prop several times and tie in a bow knot, holding the reflector in the necessary positions when the SBC is focussed.

To make a simple dark bottom tray, sheet metal may be formed into a tray by bending a lip up at half inch intervals with pliers. If cardboard is preferred over sheet metal, cut a piece of cardboard slightly smaller than the bottom of the interior of the oven and apply foil to one side. Paint the foiled side with non-toxic black paint and allow to dry. Put the darkened foiled cardboard in the oven (black side up) and place the pots on it when cooking. Whether using metal or cardboard, prepare four strips of cardboard ½" wide and two layers deep. Glue these in the bottom of the inner box on top of the foil to elevate the tray a bit above the bottom. (Diagram 3)

If using glass, place the glass inside the lid now. Seal the edges of the glass to the lid with silicon sealant keeping sealant off the surface of the glass. Foil the inner top of the lid covering the edge

of the glass and the exposed cardboard. Insert the box oven assembly. Keeping the box pressing on the glass, turn the unit over. Seal the cut edges of the cardboard to the glass, working the sealant into the corrugations. An effective way to apply silicon sealant is to slant the cartridge at a 45 to 60 degree angle. Working near the operator, start a small bead of sealant. Push the tip smoothly forward, maintaining the small bead which is spread and pushed into crevices by the advancing tip. Smooth any irregularities with a moist finger.

Finish the outside with exterior grade house paint and/or contact paper. Prepare a matching carrying strap if desired. Heat empty for 2 hours in full sun to drive off any residual vapors. Your Solar Box Cooker is now complete. Use with standard Solar Box Cooking techniques.

PREPARING A COLLAPSIBLE MODEL

The depth of Panel B of the outer strip must not exceed the width of Panel A. Mark the collapsing folds with a firm heavy line.

1) Prepare as above, forming flexible joints by joining the panels together at the vertical cut/fold lines with flexible tape such as duct tape or cloth strips glued on with non-toxic, heat-resistant glue or wheat paste. Do this by placing two panels one on top of the other like a closed book and glue a strip over the joint to allow slack for the bend. Reverse the fold and glue a second strip over the outside of the joint. The strip can then be placed in the lid with alternating folds.

In addition, for a collapsible model, do the following:

2) Instead of gluing the end flaps, secure them with temporary holds of masking tape or duct tape. (Diagram 10) One piece of duct tape goes on the primary holding surface. A second piece of duct tape with a small portion folded over to make a pull-tab is fastened on the adjoining part. A third small piece of tape goes on the opposite side of the cardboard under the pull-tab to provide a temporary holding surface for the duct tape when the SBC is collapsed.

3) The supports for the bottom may be triangular or square tubes of cardboard that can be opened to pack flat. The top flaps of the inner and outer boxes are left unsealed relying on the weight of the lid to press them together.

4) The package can be closed with a plain piece of cardboard cut to fit inside the lid. Optionally, it may be closed by making a three-sided water heater the size of the lid (Diagram 11)

5) It can all be kept inside a large, heavy duty plastic bag to protect from moisture or in any waterproof location.

6) A five or six foot one-inch cloth strap is useful to hold the package together and also to serve as a handle.

FOR TEACHING MODELS

Prepare as either a standard or collapsible SBC.

1) The bottom flaps are temporarily secured as in the collapsible model so it can be repeatedly opened to discuss construction. Access through the bottom also allows for research projects on different insulating materials.

2) In addition, instead of attaching glazing to the lid, simple double thickness frames of overlapping cardboard are made for each different glazing. Each separate frame can be placed between the unglazed lid and the oven top, thus changing the glazing at will so the differences can be studied.

Science projects may investigate temperature variations with changes in insulation or glazing. Observations can be made on the position of the reflector required at different times of day or season. Differences in warming times may be related to mass. How long heat will be retained with and without closing the reflector over cooked food, as well as with a variety of pot insulations may be studied and graphed.

Kerr-Cole Solar Box Cookers
P.O.B. 576
Taylor, AZ 85939 Phone: (602) 536-2269

See also The Minimum Solar Box Cooker -- a TWO-BOX DESIGN by Joe On and Tom Sponheim

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CHAPTER 10

USING A SOLAR BOX COOKER

Face the SBC toward the sun until the shadow of the box falls directly behind. Move the reflective lid until the light falls on the bottom in the shadowed area filling the box with sunlight. Set the prop. SBC will begin to heat up. Food takes about twice as long to cook as in a conventional oven.

Place food in dark containers preferably with tight fitting dark lids. Good solar pots are Graniteware--, cast iron, amberware, or any vessel painted dark on the outside with non-toxic dark paint. Painted pots could be any kitchen pot or pan, or a food tin, or a glass jar, etc. For safety, jars should have a hole in the lid to release steam pressure.

The golden rule of solar box cooking is "Get it on early—Don’t worry about overcooking." If you are leaving the SBC unattended for many hours, focus it ahead so temperature will peak an hour or so before you return. If done ahead of time, food will keep hot in the SBC without overcooking or drying out. Some cooks only tend their SBC three times a day. During breakfast cleanup, lunch is prepared and placed in the oven even before the sun is strong. The SBC is set for about 11 a.m. and not tended again until time to take out lunch. Long cooking foods may be put in at breakfast for the evening meal or the evening meal may be put in during lunch cleanup if easier to cook foods are being used.Use your favorite recipes. Casseroles, beans and grains need the usual amounts of water or slightly less. Vegetables and meats cook in their own juices without additional water. Green leafy vegetables cook fastest if both the SBC and the dry pot are preheated. Everything, even bread, cooks under a dark lid. Special foods such as bread, cakes, etc. go in after the SBC is preheated. Spaghetti, other pastas and gravies, retain good texture if the flour product is stirred with a small amount of oil and heated separately from the water. Combine water and flour/oil mixture for the final twenty minutes or so of cooking.

Oven temperatures naturally drop when the oven is opened and when cold food is put inside. Temperature recovers as the food heats up. Many people do not even use a thermometer.

EASY TO COOK FOODS:

(general cooking time about 2 hours)

Barley
Light breads and rolls
Bulgur wheat
Cakes
Chicken pieces
Cornbread
Fish
Millet
Squash
White rice

MEDIUM TO COOK FOODS:

(general cooking time about 3 hours)

Black-eyed beans
Heavy breads
Brown rice
Carrots—faster if cut in small pieces
Dried Corn
Lentils
Potatoes—faster if cut in small pieces
Pot roast
Large amounts of easy to cook foods

HARD TO COOK FOODS:

(general cooking time about 4 to 5 hours)

Black beans
Garbanzo beans
Kidney beans
Pinto beans
Red beans
Split green peas

Large amounts of medium to cook foods.

DEMONSTRATION FOODS:

Timing varies with local conditions. It pays to do a trial run before any initial demonstration.

Approximately 20 to 30 minutes uncovered: Nachos—Spread the chips on a tray, cover with

grated cheese. Additional trays of chips may be placed under the one with cheese in order to preheat. Schmores—Place the white marshmallow on a graham cracker, cover with a slab of chocolate. Heat top cracker separately.

Approximately 30 to 45 minutes uncovered: Hot dogs—Place hot dogs on a tray separately from the buns. Buns are placed with the brown sides up. Cookies—particularly dark ones like spice, chocolate, or chocolate chip—can be cooked with or without a lid. Light colored ones will be slower.

Ongoing bubbling with good smell: Bring food up to temperature well before the demonstration. Lid can be partially set to one side to reveal sizzling barbecue chicken, stew, simmering well seasoned bean pot, etc. White rice, particularly with pieces of carrot and pepper, is often cooked to accompany the meat for a festive meal. Expect to have to wipe the glazing periodically to remove condensing moisture if leaving the lids ajar. Food can be cooked in amberware so bubbling can be seen with the lid in place, or a small square of window pane glass can be used for a transparent lid.

INITIAL PACKING LIST FOR DEMONSTRATIONS:

Foods, pots, seasonings, hot pads, soft cloth for wiping glazing, implements for serving, napkins or small paper plates, litter bag, literature with weights in case of wind, personal care items such as a sun hat, sun screen, cool drinks or water, a chair, paper and pencil for notes and sharing addresses, etc.

INTRODUCTORY RECIPES

SCALLOPED POTATOES

SCALLOPED POTATOES

Barbara Tobi, Carmichael, CA

4 cups thinly sliced potatoes
¼ cup butter or margarine
¼ cup finely chopped onion
l can cream of mushroom soup
½ teaspoon salt
¼ to ½ cup milk
¼ teaspoon pepper
Grated cheddar cheese, optional

In a greased 2-quart casserole, arrange one layer of potatoes. Dot with butter and sprinkle with some onion, salt and pepper. Make about 4 layers. Top with mushroom soup and milk. Cover and bake about 2 hours or until a fork goes through potatoes easily. Sprinkle grated cheese on before serving, leaving cover on for a few minutes to melt cheese.

STEW

Cut meat into 1 inch chunks. Add sliced onions, garlic, or whatever. Place in dark pot with lid. Bake in SBC for 3 to 5 hours. Thicken the gravy if desired by using a flour batter.

EASY CHICKEN

Put chicken pieces—legs, breasts, wings—in a single layer on a rack in the bottom of your dark pan. Spread barbecue sauce or picante sauce. Cover and bake for two or three hours.

BEANS

2 cups soaked beans
6 cups water

Cook in a dark pot with a tight lid. If it is a semi-cloudy or winter day, bring to a boil before placing in preheated SBC. Otherwise, just put them in. Cook all day adding your usual seasoning about mid-afternoon or after beans are tender. Let cook until sun goes down.

GREEN BEAN CASSEROLE

1 10 oz. package frozen French-cut greenbeans, thawed and drained.
1 can condensed cream of mushroom soup
1 small can French fried onion rings

Combine beans, soup, and ½ of onion rings in a roaster pan. Top with the remaining onion rings. Cover and bake 1 ½ hours.

CORN ON THE COB

Bake for 1 to 1 ½ hours. May be either baked in husk or huskless.

POT ROAST

Place pieces of carrots, potatoes, celery, squash, mushroom, okra or other vegetable in bottom of pot. Add pot roast on top and season. Bake covered for 4 hours or more. Requires no water. Natural juices will remain highly flavored and blend well.

BAKED APPLES OR SQUASH

Core or cut into pieces. Place in a covered dark pan and cook for 1 ½ or 2 hours.

POTATOES, BEETS AND OTHER ROOT VEGETABLES

Cook in a covered pan for approximately 3 hours. Superb flavor.

SOUP

Plan ¾ to 1 cup for each serving. Liquid may be water, vegetable or meat stock, or tomato juice. Add cut up pieces of either garden fresh, or solar dried vegetables and about 1 tablespoons of rice, barley, millet or other grain per serving. Cook 2 to 4 hours depending on volume and size of vegetables. Top with chopped greens, shredded cheese or oiled bread crumbs.

FROZEN OR MICROWAVE FOOD PACKAGES

These prepared foods need to be removed from their insulating covers and serving dishes. Place on a plate covered with a dark lid, or in a regular solar pot. Allow 1 to 1 ½ hours for frozen food, 1 hour for microwave dishes.

GOURMET MEALS FOR SINGLE PEOPLE

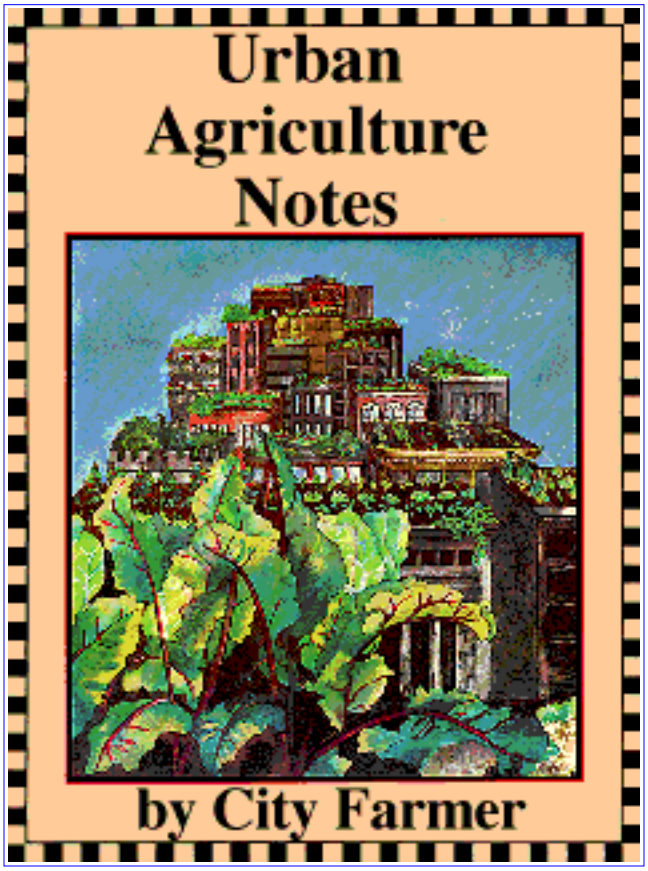
A full variety of foods can be prepared in small amounts in ½ pint jars in a dark pot or under a dark cloth. For rice and other grains allow 2 to 3 tablespoons of grain per serving. For beans allow 3 to 4 tablespoons per serving. Soak in advance. Season exactly as you like. For fresh greens and some vegetables completely fill the ½ pint for one small serving.

PASTEURIZATION OF WATER, MILK OR FORMULA

Several quarts of liquid may be pasteurized in a standard sized SBC on a good sunny day along with cooking one or two pots. Water or milk is heated to 150 F. Milk and formula should be processed either in a dark container or under a dark cloth to protect from vitamin loss. Formula is processed in glass nursing bottles, not plastic. The usual ring top and nipples may be used.

RETAINED HEAT

To keep food hot after sundown, cover the pots and tray with a blanket, insulating pads, or terry cloth towels. Close lid and reflector. If planning to hold food for several hours, place several bricks or heavy stones in the SBC after food has started to cook. Push these near the pots before covering with the insulation. Addition mass is particularly useful when cooking small amounts of food without sufficient mass in themselves to hold for long.



Urban Agriculture Notes

by City Farmer - Canada's Office of Urban Agriculture

Now Celebrating Our 26th Year!

Mayor of Vancouver Proclaims November, 2003 "City Farmer Month"!!

Established 1978, Vancouver, BC, Canada

Prepared by Michael Levenston, Executive Director
cityfarm@interchange.ubc.ca

On-line on the World Wide Web since October 15, 1994.
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"Diary of a Compost Hotline Operator" wins "2004 Garden Globe Award of Achievement" from the Garden Writers Association

Virtual Tour of City Farmer's Demonstration Garden

This new virtual tour was created by Graham Clark in April 2004. You will need QuickTime and the On2 codec installed to view the tour. This software is free and can be downloaded once you click on the link. Posted May 2, 2004

City Farmer's "Grow Natural" Gardening Series for Fall 2004

Fall Growing Grub, The Grass Class, The Water Tour, Backyard Composting, Wormshops, Soil Secrets, The Bug Shop" Posted August 14, 2004

Green Roof on our Cob Garden Shed (see Cob Oven and Cob Slideshows 1 and 2 as well)

We are on the Hotline, in a Wormshop, at Seedy Saturday, at the Home and Garden Show.

Movie: A Day in the Life of City Farmer (3 MB)

Slide Show of City Farmer Activities

44% of Vancouver Households Grow Food says City Farmer

40% of Toronto Households Grow Food

News Flash ... August 2, 2004 ... "Burundi" and "East Timor" are the 194th and 195th countries to visit our web site since we began tracking visitors! (See City Farmer's country count.) Over 4 million hits were recorded on our site during the year 2003!

Discussion Forum

City Farmer's Urban Agriculture Discussion Forum

Come in and discuss the issues!

How to find information on our site. Our web site includes both local (Vancouver) City Farmer stories and urban agriculture information from around the globe.

1. **Use the search engine:**

Search Our Site

2. **See most recently added pages:**

Most Recent Pages and Links Added (by Date)

3. **Use the topic links:**

Africa * Asia * Europe * Latin America * Middle-East * North America * South-East Asia/Australia * South Asia

Allotments/Community Gardens * Books/Media * Children * City Farmer * Entrepreneurs * Growing Food * Health/Nutrition * Hydroponics * Insects * Livestock * Policy/Planning * Rooftops/Containers * Solid Waste/Composting * Urban Forestry * Water

4. **Use quick links for Vancouver residents:**

Grow Natural * City Farmer's Waterwise Garden * Community Gardens in Greater Vancouver and Victoria * Instructions for Backyard Composting * Home Composting*

Worm Composting * Grasscycling and Natural Lawn Care * Waterwise Gardening and the City Rain Barrel Program

*** Organic Landscapers/Gardeners in Greater Vancouver * Other Rain Barrels and Water Wisdom From Around the World * How to Set Out Your Yard Trimmings * Worm Suppliers * Pet Waste Composting * Farm/Garden Land For Rent in Greater Vancouver and Elsewhere * Wholesale and Retail Native Plant Nurseries in BC * Drought Tolerant Plant List for Vancouver City Boulevards**

5. **Some popular pages on this site:**

Most Recent Pages and Links Added (by Date) * Jobs in Urban Agriculture * Bulletins/Conferences * UA References

Urban Sustainability Tours at City Farmer's Garden

"City Farmer's garden has been open continuously since 1982 at 2150 Maple Street in Vancouver. We demonstrate urban agriculture and various "green" technologies, all of which can be practiced by residents in the city. Urban Agriculture, Backyard Composters, Worm Bins, Water-wise Garden, Natural Lawn Care, Rain Barrels, Compost Toilet, Country Lane, Cob Shed, Garden Gates and Animals in the Garden." Posted September 16, 2001

City Farmer's Cob Shed - It has a Living Green Roof

Sculptor, George Rammell, donates Haida artist Bill Reid's clay to our cob project. "The clay I provided belonged to Haida artist Bill Reid. It provided the form for many of Bill's sculpture projects including the **Whale** at the aquarium, and the huge bronze **Spirit Canoe** at the airport." Updated October 9, 2003

City Farmer's Green Roof on the Cob Shed

Photos of the roof planted, our goat, and Arctic roof gardens from long ago. Posted October 9, 2003

City Farmer's Country Lane

Vancouver City Council passed a report to fund three demonstration "Country Lanes". These lanes have permeable surfaces that allow stormwater to flow into the earth rather than drain into the sewers. Updated October 9, 2003

City Farmer's Waterwise Garden

"Waterwise gardening is not synonymous with xeriscaping. Waterwise

gardening is a more appropriate explanation for gardening in mesic climates like Vancouver and incorporates the collection and storage of rainwater, soil health, maintenance techniques and the choice of appropriate plant species to create healthy, beautiful gardens. " Posted February 14 2004

Diary of a Compost Hotline Operator: Edible Essays on City Farming

New book by City Farmer's Spring Gillard! Wormshops, lawn morons, doggy doo, compost tea, resources, and romance. Meet "Ellen who wears worm earrings and belts out the 'Compost Rap' to unsuspecting participants in her vermicomposting class. Or Laurel, worm bin mural artist, Wet Coast Wes the Scarecrow, Scissor-happy Sally, and Mike their fearless leader, prone to tai-chi fits." Updated October 9, 2003

Welcome to City Farmer's home on the World Wide Web. After 26 years digging in the fields of Urban Agriculture, we want to share with you what we have learned. The Web makes it possible for us to reach a much larger audience than we were reaching before the arrival of on-line publications.

Our non-profit society promotes urban food production and environmental conservation from a small office in downtown Vancouver, British Columbia and from our demonstration food garden in nearby Kitsilano, a residential neighbourhood.

Virtual Tour of City Farmer's Demonstration Garden

This new virtual tour was created by Graham Clark in April 2004. You will need QuickTime and the On2 codec installed to view the tour. This software is free and can be downloaded once you click on the link. Posted May 2, 2004

Urban Agriculture is a new and growing field that is not completely defined yet even by those closest to it. It concerns itself with all manner of subjects from rooftop gardens, to composting toilets, to air pollution and community development. It encompasses mental and physical health, entertainment, building codes, rats, fruit trees, herbs, recipes and much more.

Our Office wants you to know about some of the issues we deal with from day to day. There are very few offices in the world that have our experience serving city farmers all year round or have done so for as many years as we have.

These pages will grow as we select the latest breaking information that comes to us, as we review our large library of resources for useful documents to put on-line, and as we hook you up with other Urban Agriculture Web sites that most certainly will emerge.

Urban Agriculture Notes is written for those who want to start up their own "Office of Urban Agriculture", for those who have already done so, and for gardeners who are curious about what we refer to as **political horticulture**.

"The one small garden of a free gardener was all his need and due, not a garden swollen to a realm;
his own hands to use, not the hands of others to command."

Sam Gamgee, The Lord of the Rings, J.R.R. Tolkien

Resource Centre on Urban Agriculture and Forestry (RUAF) Stories: **City Farmer is honoured to be a partner in this five year project.**

Call For Contributions, Urban Agriculture Magazine, No. 13, Special Issue On Urban And Periurban Forestry

"During recent decades, Urban Forestry has been developed as integrative and interdisciplinary approach encompassing the planning, establishing and management of those urban green areas in which trees are the main element, such as woodlands, parks, gardens, cemeteries, derelict land and former industrial sites, and roadside and square plantations." Posted March 3, 2004

January 31, 2004 Application Deadline for the AGROPOLIS Awards

"AGROPOLIS International Graduate Research Awards in Urban Agriculture - application forms can be obtained from the Cities Feeding People website in English, French, and Spanish and also in Arabic (not yet posted)". Posted November 11, 2003

E-Conference: Optimising Agricultural Land Use In The City Area - Access to land and water, adequate norms and regulations, integration in land use planning. 3-22 NOVEMBER 2003

"Many of the urban poor would take up urban agriculture for a living if they knew how to get access to land. Many cities in developing countries have much land in public ownership, with serious land use inefficiencies. Often one encounters many unused open spaces within the city boundaries eg., land earmarked for industry, infrastructure or housing but not yet developed, unused private land due to speculation, etc." Posted October 17, 2003

Design, Analysis and Management of Urban Agriculture For

Resilient Communities - A Course

For people in policy formulation and action planning, January 12 - 23rd, 2004. Wageningen, The Netherlands. "The course adresses promises and drawbacks of urban agriculture. It uses modern system approaches to study practical experiences, challenges and breakthroughs as brought forward by the participants. Insights from architecture, chaos theory, ecology, social science, agriculture, energy-supply and logistics provide new avenues in problems that are difficult to deal with in traditional thinking." Posted October 6, 2001

Urban Agriculture and Food Security (PDF)

and Urban Agriculture Magazine for the World Summit on Sustainable Development(PDF)

"Two special issues of the UA-Magazine have also been published. The first one, Urban Agriculture and Food Security, was distributed at the FAO World Summit on Food Security, held in June in Rome, Italy. The second, has been prepared for the World Summit on Sustainable Development, which will be held in Johannesburg, South Africa, in August 2002. Both specials can be downloaded as PDF files." Posted October 6, 2002

RUAF: Resource Centre On Urban Agriculture And Forestry

"RUAF is a global information and communications programme implemented by seven regional institutes and coordinated by ETC-International, based in Leusden, The Netherlands. RUAF is a five-year programme that is funded by DGIS (the Netherlands)and IDRC (Canada)and initiated in October 1999. The general aim of RUAF is to facilitate the integration of urban agriculture into the policies and plans of city authorities and to enhance the active involvement of all local stakeholders."
Updated October 6, 2002

City Farmer Stories:

44% of Vancouver Households Grow Food says City Farmer

"This is the first time in Canadian history a question of this sort has been asked by a professional pollster and the result is significant," says Michael Levenston, Executive Director of the 25-year-old non-profit society based in Vancouver. "That figure represents more than three-quarters of a million people in Greater Vancouver who live in households growing vegetables, fruit, berries, nuts or herbs in their yard, balcony or community garden." Posted October 6, 2002

The Love Garden - Can love be found over a compost bin?

"Our first date was at the garden. Take-out Chinese at the picnic table. I had my head in a compost bin when he walked through the garden gate. 'Hello,' he said. I looked up and there he was. Rumpled but stylish New York, with a generous dash of West Coast outdoorsman (translation: fleece), and, I recoiled, a beard

and moustache." Posted June 14, 2002

City Farmer's Urban Agriculture Survey

Please help us learn more about your involvement in city farming by filling out this short survey form. Thank you!
Posted March 25, 2000

City Farmer's Survey Results No. 2 - Second 100

See our summary. "14 people said they sold some food at farmer's markets, retail and wholesale, a coop, restaurants and caterers, traded food for services or other food, reinvested income back to an organization, sold eggs at work and to neighbours and friends."
Posted December 27, 2001

City Farmer's Survey Results No. 1 - First 100

See our summary. "People from 16 countries submitted surveys - Australia, Brazil, Canada, Denmark, Egypt, England, Germany, Hong Kong, Israel, Kuwait, New Zealand, Peru, Philippines, South Africa, Spain and the USA. The vast majority were from the USA (56%) and Canada (26%)."
Posted May 20, 2000

City Farmer Uses the Latest Aerial Photos To Find Out How Much Food is Grown in the City of Vancouver

"Looking down from the sky it's easy to see where city farmland lies. Roofs, driveways, sidewalks, swimming pools, trees, lawns and gardens are all clearly visible. The photos on this page were taken of homes in South Vancouver between Fraser and Clarke Avenues. The excellent resolution of the shots (15cm = 1 pixel) allows us to close in from an airplane-view to an almost tree-top view of homes and gardens."
Updated October 31, 2001

City Farmer T-Shirts For Sale

"Our first run. Limited quantity."
Posted September 13, 2001

Current Photos from the Demonstration Garden

"Wasup"? We get excited about new crops, visitors from other countries, creatures both pest and beneficial --- and because Mike has a new digital camera, this page exists.
Posted September 14, 2001

The Christmas Tree Shredding Ceremony

"Look, all I'll say is this. People want to know that their trees' lives haven't been sacrificed in vain; that they've served a purpose greater than a light rack. Over the years, we've recycled hundreds of thousands of Christmas trees and their

remains are composted in our yard trimmings composting facility here at the Landfill. That product is then spread around Vancouver parks and sold to landscapers and residents as a rich organic fertilizer. If that isn't a higher purpose, I don't know what is."
Posted December 29, 2001

City Farmer's Grasscycling and Natural Lawn Care Project

"Once a week, a gentle pull of the lever starts the quiet machine - there's no gas or oil to mess with, no fumes to breathe in. A simple squeeze of the lever by the right front wheel adjusts the mower height and in minutes the lawn is cut, all the clippings are out of sight, blown as tiny pieces into the lawn where they will break down and nourish the grass."
Posted May 13, 2001

Roots of a Political Plot

"The growing international movement known as urban agriculture has its origin in a 2,500-square-foot Vancouver garden"
Posted May 26, 2001

Results In! - The Best Food Garden In Vancouver Contest

"Filled with, at different times, chicory, radicchio, basil, tomatoes, kiwis, figs, grapes, prunes, pears, and corn, Calogero's garden occupies two back yards and much of the front yard. It produces something different every week, says his daughter Lucy: "[My father] has been growing vegetables since he moved from Italy over 30 years ago. My mother makes enough tomato sauce for the family year-round, and sends some to my sister in Victoria."
Updated September 22, 2000

City Farmer's Demonstration Garden: Detailed Plan Showing Plants and Features

Collin Varner has drawn a beautiful plan of our garden showing exactly where everything is located. Posted August 28, 2000

Photo Tour of City Farmer's Demonstration Garden

See it all! The vegis, the compost toilet, the worm corner, the office in a greenhouse, and much more. Posted November 3, 1999

Introduction to the Demonstration Garden

Many media events take place at our beautiful garden. Sesame Street shot a segment on worm composting. And the Mayor of Vancouver cut fresh artichokes before the cameras. Updated November 3, 1999

More Urban Agriculture Stories Can Be Found Here

City Farmer's Garden Gate

Metal artist, Davide Pan has created a distinctive front gate for City Farmer's Demonstration Garden. Posted June 28, 1999

City Farmer's History: The First Ten Years 1978-1988

Filing cabinets, desks and high shelves of books overflow with a paper record of our efforts from the past 21 years. We have chosen various documents from this archive and placed them on the following pages to give the reader a brief glimpse of our past. Posted June 6, 1999

Red Celery In the Sunshine - An Urban Eden: transforming hopeless backyard hardpan into a lush organic plot

First published in 1984 in **Harrowsmith** magazine, this article describes City Farmer's Demonstration Food Garden. "I thought for years that just compost and the occasional load of manure were enough, and I had perfectly adequate gardens, but now, I'm not satisfied with adequate. I want Brassicas that are four feet high and three feet wide." said first Head Gardener, Catherine Shapiro. Posted May 6, 1999

City Farmer Newspaper 1978 -1981

"25 cents was the street price for our 'rag'. If a copy sold in a corner store we'd get half that back from the proprietor as our share. More often, we'd never find our way back to that store, and if we did, we'd find our paper had turned yellow with age." Posted May 13, 1998

We Have a Compost Toilet!

"But how do we use it", the staff wanted to know? "There's no water in the bowl, no handle for flushing. What can we throw in it, how do we keep track of how much human waste goes in, and what words should we use to describe our waste?" Posted November 12, 1998

Composting Toilets

In Vancouver, British Columbia, a 30,000 sq. ft. office complex, utilizes composting toilets and urinals for human waste disposal. City Farmer has links to toilet manufacturers from around the world. Updated March 11, 1999

Urban Home Composting, City Farmer Style

If all our urban organic waste was turned back into crop nourishing humus, think how fertile the ground would become.

Dealing With a Rat in a Compost Bin

An individual who calls the Compost Hotline is usually quite shocked that he has a rat on his property.

City Farmer/City Of Vancouver Wormshop Program

"Half a pound of writhing red wiggler worms are included in each worm "kit". The bin will accommodate up to 1500, so participants are encouraged to make up a second bin for themselves or a friend (they make excellent wedding gifts, shower gifts and Christmas presents!)."

Worm Suppliers

The world's largest list of worm sellers. Updated January 4, 2002

More about the City's Distribution of Worm Bins!

Newsweek magazine, Feb. 12, 1996, reports "Entire cities are getting into the act. Vancouver sells worm bins, wrigglers included at half price." (Kitchen Help: Wrigglers Under the Sink, page 76)

Composting With Red Wiggler Worms

The great advantage of worm composting is that this can be done indoors and outdoors, thus allowing year round composting. It also provides apartment dwellers with a means of composting.

Jerry Seinfeld's Worm Bin
"What's The Deal With Worm Composting?"

Kramer's friend, a kooky zoology Professor at a New York museum, is leading a secret expedition into the sewers of New York to search for a new species of worm that will speed up the process of decomposition in the bin.

City Farmer Donates Garden Produce To Vancouver Hospice

"The visual appeal alone was enough to stimulate the resident's taste buds and heighten their interest in food. This is important, as often we have to work at tempting the appetites of our residents." Updated November 8, 1998

Mayor Opens Water-wise Garden

This unique water conservation garden was developed by the City of Vancouver, in cooperation with **City Farmer**. The project, funded by Environment Canada, demonstrates the principles of water-wise gardening. It is located on the street front and will be open to the public year-round. Updated August 22, 1998

Waterwise Gardening

Principal Wholesale and Retail Native Plant Nurseries on the BC South Coast and Islands (PDF format)

Vancouver Begins Disconnecting Downspouts

Disconnecting residential roof downspouts from the combined sewer system may be an important way to reduce water pollution caused by Combined Sewer Overflows.

Rain Barrels and Water Wisdom From Around the World

"Here in Bermuda all residential properties catch rainwater on the roof. Roofs are constructed of lapped limestone slate on a timber frame. The water collected drains down into a water tank which is located beneath the house."Updated October 5, 1998

*** Most Recent Pages and Links Added (by Date) ***

In 1979, almost 20 years ago, City Farmer's founding directors spoke at the 20th International Science Education Symposium about our vision of Urban Agriculture.

"Ideally we believe that simply by changing from suit to jeans, digging up a bit of lawn, and planting vegetable seeds, the city person will begin asking questions about his environment and about his urban behavior and thinking patterns."

- "To most city people soil is simply mud or dirt, not a substance in which food is born.
- "Rain, means 'no beach'. It is not seen as a drink for thirsty plants.
- "Sunny days are 'tanning days', not givers of food energy.
- "There are no such things as 'beneficial insects'. They're all big game for a can of 'Raid'.
- "Big toothed dogs are nice animals to feed. Egg producing chickens are not.
- "Left-over food, minutes after a delicious meal, becomes garbage to be trucked away out of sight rather than a valuable homemade soil conditioner."

More About City Farmer's Work - Update December, 1996

- Our Compost Hotline has received 17,000 calls since 1992.
- 3000 visitors a year come to our Demonstration Garden.
- Since 1992, City Farmer has taught 431 children's wormshops for a total of 9771 "contacts".

The Easiest Way To Predict The Future Is To Invent It

Recent Stories by Date:

IDRC-CSFS Workshops on Urban Agriculture

Presentation papers available for downloading. Workshop 1: Regional Training and Courses in Urban Agriculture and Food Security. Workshop 2: The Urban Agriculture Research Partners' Meeting: First Preparatory Workshop for World Urban Forum 2006." Posted August 12, 2004

Micro Eco-Farming: Prospering from Backyard to Small-Acreage in Partnership with the Earth

New Book: "Micro eco-farms fill in spaces that larger sized farms don't attend to. They use back yards, vacant lots, or their family's own small acreage. As they grow in number, it is anyone's guess as to what type of new economical foundation they could create." Posted August 12, 2004

An Urban Food Garden in Malaga, Spain

"Esta es una historia real que demuestra que es posible cultivar un huerto "ecol gico" en tu casa, casi sin importar donde vivas. Tan sólo necesitas sol, agua y, lo más importante, algo de interés, entusiasmo y amor a la naturaleza. Un tomate criado por tí de forma artesana y natural (sin pesticidas, ni herbicidas, ni abonos químicos) tiene el indescriptible y fantástico sabor de la satisfacción personal." Posted August 12, 2004

Continuous Productive Urban Landscapes - Designing Urban Agriculture for Sustainable Cities

New Book: "The first book on urban agriculture for architects, landscape architects and urban designers. Over 230 images give the reader a clear visual idea about the impact of this pioneering subject. Urban design is shown in practice through

international case studies. Chapter One: Carrot and City: A New Urbanism. Chapter Two: Pro Urban Agriculture. Chapter Three: Open Urban Space." Posted August 9, 2004

Environmental Youth Alliance - Urban Agriculture in Vancouver

"EYA youth worked with the Strathcona Community Garden Association to build a Community Nursery so plant material will be more readily available for local urban agriculture projects. Phase one of the project involved the construction of a lockup nursery building in order to securely store plant material and supplies." Posted August 5, 2004

A Mini-Farm Trip to Uzbekistan 2004

"This country is self-sufficient in food and only imports tropical fruits such as bananas. They are more expensive than at home so very few can afford them. Every house has a garden and as you fly over the country all you see is gardens and minifarms." Posted August 5, 2004

Urban Agriculture on the Rooftop

"Rooftops are places of fantasy and imagination - places that sit above the din and chaos of the city, engaged with and yet apart from the city's motion. Rooftops yearn for the sky and yet are grounded to the city through the buildings which they top. What better place could there be for a garden? Or even better, a garden and a source of food?" Thesis in PDF format Posted July 15, 2004

Grow Veggies and Herbs From Your Condo in Vancouver

"Freesia is offering a garden terrace with about 60 personal plots. For an additional $2,800 on top of the selling price, a buyer can purchase one of the 1.5-metre-square gardening plots and a small tool locker." Posted July 12, 2004

Urban Farmers as Extension Domain: The Case of Atteridgeville,(Pretoria, South Africa)

"The article identifies and explains three extension domains among urban farmers among the informal settlements of Atteridgeville. These consist of home gardeners, community-project gardeners, and users of open urban spaces. ... The paper concludes by calling for closer involvement of government and public extension in urban agriculture in the study area because urban farming mainly benefits the poor." **PDF download.** Posted July 9, 2004

Montreal Rooftop Garden

"This summer, Alternatives, Santropol Roulant and a range of other partners are building a major demonstration garden on the roof of the University of Quebec's TélTéUniversitTé (TelUQ) building. This 500 square meter garden, situated in the heart of the densely populated Plateau-Mont Royal neighbourhood, will be coordinated and maintained by Santropol Roulant volunteers, providing vegetables for their meals-on-wheels service." Posted July 7, 2004

The Planner in the Garden: A Historical View into the Relationship between Planning and Community Gardens

"A historical review of community garden programs in the United States since the 1890s reveals an ambivalent relationship between community gardens and the planning profession. On one hand, garden programs are praised and supported as local action to serve environmental, social, and individual objectives. On the other hand, because they are perceived as opportunistic and temporary, community gardens are largely ignored in long-range planning. (Journal of Planning History, May 2004) Subcription required for full text." Posted July 6, 2004

BBC World feature - A Growing Trend - on Urban Agriculture

" 'A Growing Trend' highlights exactly that: how different methods of producing food - small-scale, organic, natural farming and urban agriculture are on the increase. While alternatives to large-scale agriculture are often born out of necessity, these methods are proving to be highly effective at meeting nutritional and economic needs and at the same time helping to build communities and protect the environment." Posted June 18, 2004

Edible Cities from Gobar Times in India

"We cityfolk consider ourselves to be very smart. Not so, discovers Gobar Times. The modern city has a garangutan appetite and is frightfully wasteful. It takes more than it gives. It ingests tonnes and tonnes of cereals, meat, vegetables and fruits grown in rural areas far and wide; chomps, chews and digests all that foodstuff; converts some of it into human energy; burps, and then spews the remaining all out as organic garbage and sewage." Posted March 28 2004

Urban Agriculture Network - Western Pacific - Monthly Newsletter

"Urban agriculture is one counter-measure to food terrorism that must now be considered and developed. ... Good business people know that behind most threats lie opportunities. The threat of food terrorism is an opportunity in disguise for global urban and peri-urban agriculture." Posted March 24 2004

Simplifed Hydroponics and Urban Agriculture in Uruguay and Ecuador

"Simplified Hydroponics has provided real solutions for low-income families and impoverished communities in many parts of the world. MARTIN CALDEYRO describes one innovative project in Uruguay that has improved family health and living standards, and is a model for other communities in Latin America to follow." Posted February 21 2004

In The Real World, Poor People Practise Urban Agriculture

According to a needs assessment by the Millennium Development Goals

Hunger Task Force, all problems of food security in poor countries would be solved if the rich world spent US$70 billion per annum, or 0.3% of its GNP, on addressing them, mainly by building infrastructure. The fact is, they don't, and they are probably not about to do so. Meanwhile, in the real world, poor people practice urban agriculture." Posted February 19 2004

Urban agriculture: What limits?

Don Okpala, Chief of UN-HABITAT's Urban Economy and Finance Branch and Acting Director of its Monitoring and Research Division, comments in Habitat Debate, December, 2003. "In the ongoing debate over urban agriculture, UN-HABITAT focuses on food security and income enhancement for urban populations. The agency is not opposed to urban agriculture as such. But its view is that the practice must be subject to certain conditions and limitations. " Posted February 19 2004

NASA Paper Speaks of Urbanization and Agriculture

NASA says "Though cities account for just 3 percent of continental U.S. land area, the food and fiber that could be grown there rivals current production on all U.S. agricultural lands, which cover 29 percent of the country. Urbanization follows agriculture. Throughout history, highly productive agricultural land brought food, wealth and trade to an area, all of which fostered settlements." Posted February 18 2004

Urban Agriculture Reaches New Heights Through Rooftop Gardening

"A Montreal-based development organization is experimenting with a gardening system called "rooftop simplified hydroponics"ÊÑ a system adapted from the group's experiences in the developing world. During the winter of 2002, with the support of Canada's International Development Research CentreÊ(IDRC), a researcher from the development organization, expanded her knowledge of hydroponics in other countries. She worked with the University of Casablanca in Morocco and the Institute for Simplified Hydroponics in Mexico." Posted February 3, 2004

ACGA Conference: "Gardens of Diversity, Growing Across Cultures" Friday October 1 - Sunday October 3, 2004 Toronto, Ontario

American Community Gardening Association (ACGA) - Themes: Community Development, Conservation and Restoration, Diversity, Entrepreneurial projects, Food Security, Horticulture, Innovations, International activities, Politics and Public Policy, Professional and Organizational Development, Research, Special Needs, Youth, Children, School Gardens. Posted January 28, 2004

Organic Farming in Pakistan

"Organic Products, Social Qualities With Equal And Fair Trade Its Constrain

And Future, Composting As An Organic Fertiliser, Producing Pesticide Free Fruits And Vegetables, The Characteristics Of Rabbit Farming, Chiku or Sapodilla The Neglected Fruit of Sindh, Gender Issue In Rural Development Of Sindh In Pakistan." Posted January 21, 2004

Does Irrigated Urban Agriculture Influence the Transmission of Malaria in the City of Kumasi, Ghana?

"To verify the possible impact of irrigated urban agriculture on malaria transmission in cities, we studied entomological parameters, self-reported malaria episodes, and household-level data in the city of Kumasi, Ghana. A comparison was made between city locations without irrigated agriculture, city locations with irrigated urban vegetable production, and peri-urban (PU) locations with rain-fed agriculture." Posted January 10, 2004

Urban and Metropolitan Agricultural Prospects

Jac Smit, a pioneer urban agriculturalist, wrote this paper in 1978. "North American metropolitan agriculture is likely to have smaller production units, similar to family farms. It is unlikely to have lower production costs, particularly when one includes the cost of overcoming soil and air pollution. However, marketing costs are likely to be much lower with savings in transport, packaging, middlemen and wastage losses." Posted December 17, 2003

Heavy Metal Concentrations in Urban And Peri-Urban Gardens of Dzerzhinsk and Nizhny Novgorod, Russia

"The general heavy metal concentrations in the study area, however, was significantly lower than e.g. in Berlin, Hamburg, Moscow or London, which was attributed to less traffic and potential leaching due to sandy soil texture." Posted December 16, 2003

Livestock Keeping in Urban Areas

"Studies have revealed that more than 20 000 households in Bamako keep livestock in town, and thousands more people supply them with inputs or marketing services; over one-third of households surveyed in Harare keep livestock, mainly chickens but also rabbits, pigeons, ducks and turkeys. In Dar-es-Salaam urban farming is the second largest employer after petty trade and labour, and 74 percent of urban farmers keep livestock; and even in densely populated Cairo, 5 percent of households keep animals, especially chickens and pigeons. " Posted November 20, 2003

Lead Levels Of Edibles Grown In Contaminated Residential Soils: A Field Survey

"Some edible portions of the leafy vegetables and herbs, however, were found to have lead levels that, if consumed, could contribute to the total body burden of lead. Therefore, urban gardeners should test the lead levels in their soils and develop strategies to ensure safety.". Posted November 20, 2003

Mayor of Vancouver Proclaims November "City Farmer Month"!!

"AND WHEREAS City Farmer is recognized as one of the leaders in providing service and information out to the world about urban agriculture, waste reduction and sustainability;.NOW, THEREFORE, I, Larry Campbell, Mayor of the City of Vancouver, DO HEREBY PROCLAIM the month of November 2003 as "CITY FARMER MONTH" in the City of Vancouver." Posted November 8, 2003

Urban Agriculture in Kano, Nigeria - Three Reports

They are: "Feeding Africa's urban poor: urban and peri-urban horticulture in Kano, Nigeria", "Urban agriculture under threat: the land security question in Kano, Nigeria", and "Water, land and health in urban and peri-urban food production: the case of Kano, Nigeria". Posted November 2, 2003

Feeding Africa's Growing Cities Into The 21st Century: The Potential Of Urban Agriculture

"From a survey of literature and detailed empirical evidence from Kano and Dar es Salaam, this paper presents a framework for analysing urban agriculture and proposes a number of policy recommendations which could possibly enhance its future sustainability." Posted November 2, 2003

Urban and Peri-Urban Agriculture - A briefing guide for the successful implementation of Urban and Peri-urban Agriculture in Developing Countries and Countries of Transition

FAO's "Food For the Cities" web page links to a number of excellent reports in PDF format. As well as the title shown above by Dr. Alex Drescher, there are three other files by the same author titled: "SOFA - Special Chapter on Urbanization "Urbanization - Linking Development Across the Changing Landscape" Updated October 26, 2003

Kenya - Experts Call for Urban Farming Policy

"According to Eric Kisiangani of ITDG "officially sanctioned and promoted, urban agriculture could become an important component of urban development and make more food available to the urban poor in Kenya besides providing employment in a moribund economy that Kenya is"." Updated October 26, 2003

British Pathe News Reels Show Historic War Garden Programs

"You have to see the clip of the chimpanzee dressed in clothes using tools to dig in his vegetable patch, or the children digging in allotments in amongst bombed out buildings after the Blitz in London. Then there are the costumed British actors advising people to prepare their winter gardens and still another film of school

children watering gardens during WW1 dressed in outfits from fashion long gone, - unbelievable. " Posted October 22, 2003

Kathmandu Rooftop Organic-Hydroponics Project (KROHP)

"Combining composting and locally constructed 'simplified' hydroponics technologies, along with grey and rainwater collection for irrigation, this project encourages a form of urban agriculture that integrates energy and resource efficient production to create an innovative and sustainable industry." Updated October 13, 2003

Green Roofs, An Icon For Our Urban Future

"Roofs able to hold the weight of 12 to 18 inches of soil can successfully grow large quantities of produce such as hot and green peppers, cucumbers, sweet potato, tomatoes, and eggplant. With ongoing research and development of lightweight growing media, rooftop greenhouses, and hydroponic techniques, the potential to grow crops on a wider range of rooftops will continue to increase." Posted October 10, 2001

Farm Experiment Thrives In The City - Philadelphia

"Farmers Lori Albright (left), 32, and Nicole Shelly, 28, have worked since March on the farm, which is expected to gross $25,000 this year. The pair usually work 45-hour weeks for $7 an hour. " Posted October 8, 2001

Design, Analysis and Management of Urban Agriculture For Resilient Communities - A Course

For people in policy formulation and action planning, January 12 - 23rd, 2004. Wageningen, The Netherlands. "The course adresses promises and drawbacks of urban agriculture. It uses modern system approaches to study practical experiences, challenges and breakthroughs as brought forward by the participants. Insights from architecture, chaos theory, ecology, social science, agriculture, energy-supply and logistics provide new avenues in problems that are difficult to deal with in traditional thinking." Posted October 6, 2001

Community Gardening In The City Of Ottawa

"There are 19 community gardens currently in the City of Ottawa, with approximately 1,080 gardeners. Fourteen of the 19 community gardens are currently on land owned by the City of Ottawa; two are on church property, two are on private land, and one is on property owned by the University of Ottawa. The Gloucester Allotment Garden Association has two locations, one of these is on NCC land leased by the City and the other is on City property." Posted September 14, 2001

Green Roof on our Cob Garden Shed

See all the stages involved in building a green roof. Posted September 12, 2003

BC Mushrooms - Non-Timber Forest Products (NTFP)

"The pine mushroom (Tricholoma magnivelare), is by far the most valuable

commercially harvested mushroom (in BC). Other valuable edible mushrooms are the chanterelles, morels, lobsters, boletes, cauliflowers and hedgehogs." Posted September 2, 2003

New Agricultuist Magazine - Focus on Urban Agriculture

"Often illegal, and usually ignored by planners and policy-makers, the growing of crops and keeping of livestock by town and city dwellers creates both opportunities and risks. Urban consumers may enjoy improved availability of fresh vegetables, milk or poultry products." Posted August 31, 2003

2003 AGROPOLIS Awardees

12 new urban agriculture research awards presented, e.g. "Impact of wastewater irrigation on crops and consumers in Kumasi, Accra, and Tamale [Ghana]" and "Evaluation of the socio-economic determinants and benefits of urban agriculture: The case of Kadoma, Zimbabwe" Posted August 31, 2003

Advisers or spies? Why some people fear communist infiltration in this Caracas garden. Fears of Cuban 'infiltration' in Venezuela

"The controversy has arisen because many of the advisers assisting with the gardening programme are Cubans. And Mr Chavez's opponents, who accuse him of desiring to convert Venezuela into a communist dictatorship similar to that led by his friend, Cuban leader Fidel Castro, suspect that the Cubans are here to do more than teach farming." Posted August 24, 2003

The Garden City Handbook

PDF download. "Over the past two years, Greater Victoria has lost two of its precious community gardens to development. The Handbook provides a description of the current context and circumstances of community gardens across the region. ... It offers a range of alternatives for ensuring that community gardens are protected and provides community groups with guidance for starting gardens and ensuring that they thrive over the long term." Posted August 20, 2003

Seeds of Success

PDF download. "Cities across Canada and the United States offer models for creating and maintaining community gardens. Seeds of Success reveals the range and breadth of possibilities for integrating community gardens into the fabric of communities and protecting these gardens from development. ... Within smaller cities, including Inuvik, Waterloo and Bloomington, local governments and nonprofit groups are adapting community gardens to the specific needs of their citizens." Posted August 20, 2003

Landmarks: A touch of Tolkien Emerges at Kits Demo Garden

Story in the West Ender newspaper. "When completed, the tool shed will have

a living green roof, a surrounding bench area and an impressively sculpted cob cooking oven. It will be festooned with a relief sculpture depicting the stratification beneath the topsoil surface: rocks, roots, old fossils, shells and some gnome-like creatures. The door to the structure is a work of art itself, resembling a rounded ship's hull, and several inches thick." Posted July 18, 2003

Drought Tolerant Plant List for Vancouver City Boulevards

"List compiled by volunteer Master Gardeners from Van Dusen Botanical Garden for the Prince Edward Street Waterwise Blooming Boulevard Project. Because soil and water conditions vary, results cannot be guaranteed. This list is intended as a guide to those plants which have proven drought tolerant in average conditions"(Large page/slow loading) Posted July 13, 2003

The Status Of Urban And Peri-Urban Agriculture In Windhoek And Oshakati, Namibia

"The study showed that urban and peri-urban agriculture is practised by over 70% of the residents of Windhoek and Oshakati, and that over 23 types of vegetables and fruit trees are grown on tiny plots. Most of the produce is consumed by the household and contributes to improvement of their nutritional status. The absence of policy on urban and peri-urban agriculture is seen as a serious constraint towards its intensification and development." Posted July 9, 2003

New Village Journal: Issue Two: Urban Agriculture

Urban Agriculture: A Revolutionary Model for Economic Development Forward and Profiles by Chris Lazarus
Urban Aquaculture by Beth Ferguson
Profiles in Urban Agriculture
The Food Project- Roxbury and Lincoln, Massachusetts
Isles Community Farm- Trenton, New Jersey
Fairview Gardens- Goleta, California
Annex Organics/ Field to Table- Toronto, Ontario
Greensgrow Farm- Philadelphia, Pennsylvania
Growing Home- Chicago, Illinois
Village of Arts and Humanities- Philadelphia, Pennsylvania
The Urban Agriculture Network- Washington, D.C.
Resources in Urban Agriculture
Updated May 3, 2003

New Village Journal: Premier Issue: Community Gardens

Reclaiming the Sacred Commons (Full article in Acrobat PDF format, 370K) by Karl Linn
The Death of Little Puerto Rico: New York City Gardens Plowed Under by Urban Development by Sarah Fegusen
Brief History of Grassroots Greening in New York City by Sarah Fergusen
Resources: Community Gardening
Updated May 3, 2003

Cuba Exports City Farming 'Revolution' to Venezuela

"Inspired by Cuba's system of urban market gardens, which has been operating for several years, left-wing President Hugo Chavez has ordered the creation of similar intensive city plots across Venezuela in a bid to develop food self-sufficiency in the world's No. 5 oil exporter. Inside Fuerte Tiuna military headquarters, soldiers of the crack Ayala armored battalion supervised by Cuban instructors have swapped their rifles for shovels and hoes to tend neat rows of lettuce, tomatoes, carrots, coriander, and parsley." Posted April 28, 2003

A Healthy Garden is a Healthy Ecosystem

"The best way to solve plant health and pest and disease problems is not by cleaning the garden and applying fertilizers and pesticides. Simple horticultural practices such as soil improvement, effective deep watering and increasing the variety of plant material are the best way to create a stable and healthy garden." Posted April 21, 2003

Family Business Garden: A New Dimension Of Urban Agricultural Extension In Colombo, Sri Lanka

"The Census of Population and Housing of Sri Lanka-2001 shows that urban population has risen and the highest urban population of 54.7% is concentrated in the Colombo district. The main theme of the concept of Family Business Garden is to stress the need in converting simple form of home gardening or kitchen gardening into the entrepreneurship development venture on the long-term basis. It based on conservation of resources and aesthetic values in association with mental satisfaction." Posted April 12, 2003

Seeds Of Our City : Case Studies From Eight Diverse Community Gardens

"We were interested in learning how much food can be grown in the typical community garden plot, and what kind of impact it has on the food security of the people involved. Essential to this study was the involvement of a core of dedicated gardeners who settled in Canada from many different countries: China, Ghana, Jamaica, Sri Lanka, and Vietnam." Posted April 1, 2003

The Garden Project

"The Garden Project, a nine-year-old gardening and job-training program, has provided free food to soup kitchens and residents of the Bay Area's poorest communities for years. Based at the San Francisco County Jail, the program trains 15 ex-prisoners each year to grow organic vegetables and helps them make the transition into a legal working life. " Posted April 1, 2003

Diary of a Compost Hotline Operator: Edible Essays on City Farming

New book by City Farmer's Spring Gillard! Wormshops, lawn morons, doggy

doo, compost tea, resources, and romance. Meet "Ellen who wears worm earrings and belts out the 'Compost Rap' to unsuspecting participants in her vermicomposting class. Or Laurel, worm bin mural artist, Wet Coast Wes the Scarecrow, Scissor-happy Sally, and Mike their fearless leader, prone to tai-chi fits." Posted March 29, 2003

The ideal project is one where people don't have meetings,
they have lunch.
The size of the team should be the size of the lunch table.

Bill Joy, cofounder of Sun Microsystems

Argentine Postage Stamps Celebrate Urban Agriculture

"The design of the first stamp is of two united hands that tend to the gardens and the produce they yield, while the other stamp depicts a stalk of corn. Both have as a background, city plans, evoking the urban context of community gardens. -- The series takes into the account the current state of the economy in the Argentine Republic, and recognizes its terrible effect on the large numbers of families who live below the poverty line and it acknowledges the effects of the lack of food on these people." Posted March 23, 2003

Supporting and Encouraging Initiatives of Urban Agriculture in Gaza Refugees Camps

"The low standard of living in Gaza strip, the low income of individuals, the mass unemployment, the rapid population increase, ... a great number of families living in and off the cities, depend on Urban Agriculture to create job opportunities to elevate their standard of living. The majority of refugees in camps and city dwellers in Gaza Strip are farmers in origin." Posted March 22, 2003

Six Student Essays on the Theme: Ag Science in the City: "The Importance of Agriculture for Urban Areas

Click on report: **Boundless Science for Bountiful Agriculture: Winning Student Essays, 2003.** "How can a city dweller eat healthier, live in a better environment, and save money all at the same time? Natural resources are limited in

urban areas, so nothing should go to waste. Urban agriculture is our chance to save money, help our environment, and improve health. Urban agriculture can benefit all of society." Posted March 22, 2003

Arachnophobia in the Garden of Food and Flowers

"Then I turned the page to the real horror show - the three monsters known as House Spiders. In university I called them the Cheap Basement Suite Spiders. The first of this group is the Barn Funnel Weaver. This is the guy making those thick webs in dark, damp basements and in the corners of old house windows in horror movies. The Hobo Spider has an "alarmingly ugly bite" and the Giant House Spider, which is in the author's words "quite frankly, the creepiest bug in the whole darn province of BC." " Posted March 19, 2003

Aquaponics

"Aquaponics is the combination of intensive aquaculture (fish farming) and hydroponics (growing plants without soil). In an aquaponic system, the fish consume food and excrete waste. Beneficial bacteria convert the waste to nitrate which the plants use in the growth process. Many backyard gardeners are setting up systems to grow hundreds of pounds of fish and all the fresh vegetables a family needs." Posted March 17, 2003

Victory Garden Network Providing Urban Agriculture Grants

"The International Victory Garden Network is currently providing grants of up to $10,000 to food security organizations or activists who want to initiate innovative pilot projects around issues of urban agriculture and urban food insecurity in the spirit of the World War 2 Victory Gardeners." Posted March 7, 2003

Wastewater's Value in Urban and Peri-urban Agriculture

"The use of urban wastewater in agriculture is a centuries old practice that is receiving renewed attention with the increasing scarcity of fresh water resources in many arid and semi-arid regions. Driven by rapid urbanization and growing wastewater volumes, wastewater is widely used as a low-cost alternative to conventional irrigation water; it supports livelihoods and generates considerable value in urban and peri-urban agriculture despite the health and environmental risks associated with this practice." Posted March 5, 2003

In my Backyard: Growing a Sense of Place in Bankside

"In the book you will discover: How a Bangladeshi garden group has helped create friendships, a sense of community and some tasty meals; Why sheep and goats were grazing in the middle of an inner-London local park; That Bankside used to be two riverside gardens, with orchards and vineyards." Posted March 3, 2003

Feast Your Eyes: The Unexpected Beauty of Vegetable Gardens

"Pennington tells a terrific story of the rise and fall of ornamental vegetable gardening between the seventeenth and the nineteenth centuries, and its comeback in

the twentieth. The cast of supporting characters is made up of both familiar figures (Thomas Jefferson, Alexander Pope, etc.) and obscure heroes of horticulture and landscape architecture." Posted March 3, 2003

Training Organic Farmers & Gardeners: Resources for Instructors

This 600-page manual covers practical aspects of organic farming and gardening, applied soil science, and social and environmental issues in agriculture. Units contain lecture outlines for instructors and detailed lecture outlines for students, field and laboratory demonstrations, assessment questions, and annotated resource lists." (PDF edition available on-line) Posted March 3, 2003

Urban Cultivation In Accra: An Examination Of The Nature, Practices, Problems, Potentials And Urban Planning Implications

"Exotic vegetables and ornamental crops from Europe were purposely grown to feed the European settlers and to beautify their residences; the cultivation of vegetables was confined to the residences of European civil servants and merchants and the castles and forts which served as both the seat of government and the homes of the colonial administrators." Posted February 13, 2003

The Richmond Fruit Tree Project

"Plums, apples and pears are picked from August through into October from the gardens of Richmond residents. A fruit tree registry and a fruit identification program are in the works." Posted February 13, 2003

Changes In Official Attitudes Towards Urban Agriculture In Accra

"This paper is about urban agriculture, which is one of the most important informal sector activities chosen by urban dwellers in Accra. It explains why officials initially held negative attitudes toward urban agriculture. It also identifies the factors that contributed to changing official attitudes. It is noted that Ghanaian officials began supporting and even encouraging urban agriculture once they realized the importance of the practice." Posted February 13, 2003

Reusing Organic Solid Waste In Urban Farming In African Cities: A Challenge For Urban Planners

"Urban and rural communities in Africa have a long history of resource conservation through waste reuse and the application of composted organic waste for farming. This paper examines the concept of waste reuse urban farming (WRUF) as a unique local solution to address municipal solid waste problems in African cities." Posted February 13, 2003

Green Roofs

"They also create space for food production in the city. The herbs used on some 6000 meals a day served at Toronto's Royal York Hotel come fresh-picked from the hotel roof. In Vancouver, chefs at the Fairmont Waterfront Hotel help pay for the roofs over their heads by harvesting $30,0000 a year worth of food, including original marsh mallows used for exotic treats." Posted January 23, 2003

Ministry of Agriculture Allotment and Garden Guides - 1945

"A series of 8 pamphlets published by the U.K. Ministry of Agriculture at its wartime base at the Berri Court Hotel in Lytham St. Annes, Lancashire, England. The pamphlets were published for January through July and December 1945 '...to help you to get better results from your vegetable plot and your fruit garden.' " Posted January 19, 2003

Microfarming at High Latitudes: A Resource for Small-scale, Cold-climate, Food security

"I'm also concerned mainly with special conditions encountered in cold weather climates at high latitudes, that is, above 40 degrees north latitude. I am located at 61 degrees 36 minutes north. Most of the garden books I've read dealing with northern climates, define the far north as the upper peninsula of Michigan. Most never venture into Canada, and very few even mention Alaska." Posted January 17, 2003

Introductory Manual for Greening Roofs

"This manual provides a practical introduction to building green roofs in Canada. It outlines the economic and environmental benefits to green roofs as well as barriers such as safety and maintenance issues. The manual gives a thorough discussion of design and construction considerations including loading, building codes, microclimate, membranes, growing medium and drainage."(PDF File) Posted January 17, 2003

450,000 Huertas or Vegetable Gardens in Argentina

"Most of them have emerged since the mid-1990s. The average size of the huertas is 100 square metres for family-run plots, 200 square metres for schools and 1,000 square metres for community plots. Around 2.5 million people receive some food from the plots, and there are now more than 5,600 school plots and 2,300 community plots." Posted January 15, 2003

Taiwan Urban Agriculture

"As you can see, despite the urban chaos, the steep slopes of the area allow for much of the space to be utilized for agriculture. Much of the green space that you can see has some kind of agriculture, whether it be food crops or flowers." (This travel journal will be updated over the next few months.) Posted January 8, 2003

Victory Garden Contest Winner 1942

"My grandfather (Jack Reading) won 1st prize in the 'Vancouver Sun' Victory Garden contest in 1942. I have photos of the garden, the prize letter from the Sun and the original newspaper clipping with all the various winners names." Posted

December 28, 2002

Botswana Civic Leaders Visit Toronto Community Gardens

Solomon Boye, originally trained in his native Ghana, takes over. Gardens are wonderful for young people who are feeling lost and angry, he says. "We tell them that nature's laws are relentless; if you don't seed, you won't harvest, if you don't care for the plants, they will die. It is not adults who are demanding obedience. It is nature demanding cooperation." Posted December 27, 2002

City Farmer - Site to Visit - Garden Inspired Tourism

"Garden Inspired Tourism's mission is to act as a catalyst and to facilitate the development and promotion of BC as a globally recognized garden interest destination. Beautiful British Columbia offers year round garden interest with seasonal showings beginning as early as February and lingering on until November, and with unique winter gardens and festivals." Posted December 25, 2002

Urban Community Gardens Fight To Save Their Space

"New York City's community gardeners have been waiting anxiously for more than two years to learn if the green spaces they love will escape the bulldozer. In 2000, New York's Attorney General, Eliot Spitzer, filed a lawsuit that froze construction of 2,922 apartments scheduled to be built on current community garden sites." Posted December 25, 2002

Southeast False Creek Urban Agriculture Strategy

"While the study of urban agriculture has gained considerable momentum in North America and elsewhere, and even become fashionable in recent years, this study may be the first of its kind in North America to focus solely on the role that food-related activity and urban agriculture could play in the comprehensive planning of a new neighbourhood." Posted December 15, 2002

A Training Manual on Urban And Peri-Urban Agriculture (For Nepal)

"The training manual has suggestions, ideas, recommendations and technologies which can contribute to UPA development in Nepal. Urban and Peri Urban Agriculture (UPA) has been in existence in Nepal since time immemorial. The Jyapus of Kathmandu were excellent producers of food in the valley. Similar groups are also found in other parts of Nepal. This training manual will present information which will help to improve traditional technologies. It will present new appropriate technologies which will be useful to the urban and peri-urban farmers in food production, processing, preservation and utilization. (21,000 words)" Posted December 10, 2002

Urban and Peri-Urban Agriculture in Nepal (Partners and Expertise)

"Urban population is increasing in all the urban areas in Nepal. More satellite towns are getting established and older cities are getting more crowded. Traditional

agricultural systems are changing. Farming in or around urban and peri urban areas is getting more sophisticated and focused. This publication can be a useful companion/reference material for anyone who is interested in urban and peri urban agriculture in Nepal. The names and addresses presented in this publication were collected from within the whole country. (12,000 words)" Posted December 10, 2002

Urban and Peri-Urban Agriculture Directory (People, Organizations and Enterprises - Nepal)

"This is a directory of addresses of government departments, aid agencies, international and national non-governmental organizations, community based organizations, and individuals who are involved in urban and peri urban agriculture in Nepal. Urban and peri urban agriculture does not receive the importance it deserves from the government or other donor agencies because it is mostly practiced by the poorer section of the urban population. This group own small pieces of land, practice customary farming practices and produce food to meet the needs of the family and mainly of their traditional customers. (16,000 words)" Posted December 10, 2002

Call For Contributions, Urban Agriculture Magazine, No. 9, Financing Of Urban Agriculture

"Financing urban agriculture is broader than just the provision of credit to urban farmers. Next to formal credit, other forms of financing are considered, like informal loans, tax incentives, controlled land rent, subsidies on certain inputs, investment (of Government or private sector) in infrastructure or technologies, etcetera." Posted November 26, 2002

The Rainwater Harvesting CD

"The information has been collected from all over the world, from South and North, and from rural and urban areas. The emphasis is on domestic use of rainwater harvesting. The CTA Study Visit in Kenya shows many photos (additionally explained by voice) of different possibilities of rainwater harvesting used in Kenya." Posted November 23, 2002

"Home Grown" by the Worldwatch Institute

"In the United States, food typically travels between 1,500 and 2,500 miles from farm to plate, as much as 25 percent farther than in 1980. For some, the long-distance food system offers unparalleled choice. But it often runs roughshod over local cuisines, varieties, and agriculture, while consuming staggering amounts of fuel, generating greenhouse gases, eroding the pleasures of face-to-face interactions around food, and compromising food security." Posted November 21, 2002

Urban Fringe Agriculture

Report of the Asian Productivity Organization (APO) Seminar on Urban Fringe Agriculture held in Tokyo from 17 to 24 May, 2000. Examples of Stories: **Transition of Urban Farmland Policy and Development of New Urban Agriculture in Japan** (Kenji Ishihara), and the **Present Situation of Urban Agriculture and Related**

Problems (Mitsuzo Gotoh) Posted November 18, 2002

An Olympic Sized Urban Agriculture Idea from Greece

... from the Olympic Village Athens 2004 architectural team who prepared the greenest proposal... "Hydroponic plantations on the roof, fish farming for nitrate water purification, bioclimatic roads, active thermal capacity of the structure with use of inter-seasonal thermal storage, almost all of the architects aspirations are found in this proposal." Posted November 29, 2002

Community-Based Urban Agriculture As History And Future:

Jac Smit ... "It is clear reviewing 25 years of studies of urban agriculture that urban farming is expanding more rapidly than rural agriculture or agriculture as a whole. No surprise, it's happening in an urbanizing world. Agriculture is reinventing itself to fit the new reality of human settlement on the earth." Posted November 6, 2002

40% of Toronto Households Grow Food says City Farmer

"These figures represent more than two and one half million people in Greater Toronto and Vancouver who live in households growing vegetables, fruit, berries, nuts or herbs in their yard, balcony or community garden."" Posted November 6, 2002

Homestead Food Production - A Strategy to Combat Malnutrition & Poverty

"Home Gardening is a key program activity for Helen Keller International (HKI) in the Asia-Pacific region. In 1988, HKI conducted a pilot Home Gardening project among 1,000 households in Bangladesh. Today, the Gardening and Nutrition Education Surveillance Project (NGNESP) has achieved nationwide coverage and reaches approximately 800,000 households throughout the country - indeed it is the largest program of its kind in the world." 142 pages, 2001, large PDF (9.7 MB) November 5, 2002

2003 Post-Doctoral Awards in Urban Agriculture - New this year

"AGROPOLIS is an International Research Awards Program that supports innovative research in the field of Urban Agriculture. Starting this year, the AGROPOLIS Program will offer up to two (2) post-doctoral awards to promising researchers who have obtained a Ph.D. in urban agriculture or in a related field and who wish to specialize further in their field."
October 25, 2002

City Farmer Cob Workshop: June 9 - June 15, 2003

One week intensive - limited enrollment - $400. City Farmer's Compost Demonstration Garden in Kitsilano is to be the site of Vancouver's first cob garden shed. Cob is an ancient building method using clay, sand and straw. Building with earthen materials pre-dates the pyramids.
Updated October 22, 2002

Philippine References - Urban Agriculture

12 papers and a book are referenced, including: "Allotment Gardens for the Philippines: A Contribution to Urban Food Security"; "Quality and quantity requirements for vegetables by private households, vendors and institutional users in a Philippine urban setting"; "Urban Agriculture - A Step-By-Step Guide To Successful Container Gardening in the City"; and "Appropriate methods for microenterprise development in urban agriculture". Posted October 21, 2002

The Urban Agriculture Network (UAN) President's Annual Report 2001/2002

"The importance of urban agriculture is becoming recognized as an important element of programs for not only food security, but also for sustainable urban development and efficient provision of the necessities to low-income families. UAN wants to expand its central coordinating role in making urban agriculture a reality throughout the world." Posted October 11, 2002

Ground Work: Investigating the Need for Nature in the City

"The individual and community health benefits include the development of stronger neighbourhood ties and a sense of community, reduced rates of crime and violence, and increased recreational opportunities. In addition, contact with nature has been shown to have positive physiological and psychological effects on people, including decreasing stress, restoring mental energy and reducing the recovery time from illness. " Posted October 10, 2002

44% of Vancouver Households Grow Food says City Farmer

"This is the first time in Canadian history a question of this sort has been asked by a professional pollster and the result is significant," says Michael Levenston, Executive Director of the 25-year-old non-profit society based in Vancouver. "That figure represents more than three-quarters of a million people in Greater Vancouver who live in households growing vegetables, fruit, berries, nuts or herbs in their yard, balcony or community garden." Posted October 6, 2002

Toronto's Official Plan from the Perspective of Community Gardening and Urban Agriculture

"'Urban agriculture' is often viewed as an oxymoron. The city displaces agricultural land; it doesn't create it. Or so conventional wisdom would suggest. Yet, in cities around the world, urban agriculture and a city's role in supporting it, has gained new prominence." Posted October 3, 2002

A Deeper Ecology: Community Gardens in the Urban Environment

"In their article, Kameshwari Pothukuchi and Jerome L. Kaufman point out that it is the food system that is missing "from the writing of planning scholars, from the plans prepared by planning practitioners, and from the classrooms in which planning

students are taught". Discounting the food system as part of a community development plan, which helps to strengthen the sense of place and belonging and aids in improving the overall environmental quality of an area, is an opportunity lost." Posted September 30, 2002

The Rural-Urban Interface, Idealistic Visions and Current Projects in Lisbon, Portugal And Santiago, Chile. -- La Interfase Urbano Rural, Idealidades Y Proyectos. Acerca De Los Casos De Lisboa, Portugal, Y Santiago De Chile.

12,000 word paper in Spanish. "Urban and peri-urban agriculture successful practises are presented as examples to be followed by other big cities, intended to reduce socio-economic differences, and to diminish the occurrence of hazards as floods, soil contamination, air pollution and green spaces retraction within metropolitan areas." Posted September 27, 2002

The Mango City: Urban Agriculture in Belém, Brazil

"It is a tribute paid to a hard working and ingenious people, who against all odds survive in one of the poorest metropolis in Latin America, frequently complementing their monthly income with fruits, herbs, spices, medicinal plants, and all sorts of animals, cropped or raised in front and backyards, in idle public and private plots, existent either within the urban tissue or in the wider peri-urban areas." Posted September 24, 2002

Inuvik Community Greenhouse - Arctic Food Growing!

Inuvik, which means "Living Place" in Inuvialuktun, is a town of 3200 in the upper corner of Canada's North West Territories. It enjoys 56 days of twenty-four hours of daylight (late June, July and part of August) and has 30 days without sunlight mostly in the month of December. "We are the most Northern commercial greenhouse in North America and the largest community greenhouse of it's kind on the planet." Updated December 3, 2002

Greensgrow Philadelphia Project

"Begun as a commercial hydroponics lettuce farm supplying high-end gourmet greens to restaurants, Greensgrow now operates a CSA and Farm Market while continuing to serve the Philadelphia restaurant community with the products of our and other local farms. We serve as a clearinghouse of information on urban agriculture issues [and] advocate adoption of urban agriculture as a tool for neighborhood redevelopment..." Posted September 19, 2002

Rural Allotments and Sustainable Development: A Japanese Perspective

"Allotment gardens first appeared in urban Japan in the 1920s (Kinoshima, 1994), and enjoyed only limited success, even in the preferred kleingarten model, prior to the Pacific War. With the outbreak of hostilities, the same enthusiasm for growing vegetables which had British and American gardeners "digging for victory"

swept Japan as well, and vacant plots of land everywhere were brought into cultivation." Posted September 19, 2002

Urban Farming - Reconnecting the City to the Land - by Michael Ableman

"And so in memory of the thousands of people who lost their lives in New York, I propose that a portion of the former site of the World Trade Center be converted to an urban farm, replete with greenhouses and kitchens and an education center. I propose that this farm be established to provide food and jobs year-round to those in need and become a model of a local agriculture-based economy that we can look to as the global and military one begins to crumble." Posted September 16, 2002

Tiny Bubbles to Make Your Garden Grow

"How much fuel energy does it take to grow tomatoes in a Lanark County greenhouse in January when it's, like, -10 C outside? Well, if you're Kathryn and Ross Elliott of "Lively Up" Winter Harvest, less than $6 a month worth, or about $70 a year. That's instead of an estimated $3,000 a year to run a comparably sized greenhouse heated with propane or natural gas." Posted September 16, 2002

Growing Gardens

"We serve the St Johns, north, inner north/northeast and outer southeast low-income areas of Portland, Oregon. Requests for gardeners come by word of mouth, presentations to groups such as the WIC (Women, Infant and Children) programs, as well as strategic contacts made by staff to housing agencies such as the Housing Authority of Portland and local public schools." Posted September 15, 2002

Vacant Land in Latin American Cities

"As long as significant amounts of urban land remain unoccupied, equally important numbers of poor urban residents will continue to occupy land lacking infrastructure of services, located in areas not appropriate for urban development. This pattern both creates precarious habitats and deepens the processes of socio-spatial segregation." Posted September 14, 2002

City of Vancouver May Ban Cosmetic Use of Pesticides on Lawns and Gardens.

"The use of Integrated Pest Management on public lands has illustrated that significant reductions in the use of pesticides on lawns and gardens can be achieved without sacrificing overall landscape quality. This direction would further reduce or eliminate both known or possible environmental and health risks." Council Decisions on Report. Updated September 16, 2002

Indigenous African Food Crops and Useful Plants: Their Preparation for Food, and Home Gardens

Here is a report with information on home gardens in Kenya, Edo and Delta States of Nigeria, Anambra, Enugu, Benue, and Kogi States of Nigeria, Southeastern

Nigeria, Northern Nigeria, West Africa, Cameroon, and Ghana, Eastern and Southern Africa, Zimbabwe, Tanzania, Niger, Ethiopia, Ghana. The whole book is available as a PDF. Posted August 22, 2002

Transition to Ecological Urban Agriculture: A Challenge

Urban Agriculture Magazine May, No. 6, March 2002 "Ecological agriculture is seen as especially relevant to the urban setting. The introduction in rural settings of ecological practices is still debated, although it seems that the call for the coexistence of both conventional and ecological farming in an adequate mix seems to be the best option." Posted August 20, 2002

The Urban Farmers Almanac - A Journal of Post Punk Gardening

A new urban agriculture publication featuring stories titled **Minneapolis Squatter Gardens, Small-Scale Urban Soybean Farming**, and **Low-Light Indoor Agriculture**. The author "created this site... to serve as a psychological steam valve". "Everyday I spend festering in this rotten city working on my graduate degree (Masters of Agriculture in Horticulture) makes me more and more insane." Posted August 14, 2002

Evaluating the Potential of Green Roof Agriculture

"I established an experimental vegetable garden on the green roof of the Trent University Environmental Sciences building. I was looking at the suitability of green roofs for urban agriculture, comparing different crops and growing conditions." Posted July 28, 2002

More Urban Agriculture Stories Can Be Found Here

Jerusalem Cityfarmers

"Jerusalem Cityfarmers is a network of people from Jerusalem's diverse communities working for ecological use of our shared resources - in Jerusalem, in our bioregion, and our planet. We believe that every individual and community has untapped potential to create local solutions." Posted July 28, 2002

Cobequid Community Gardens

"In Truro, Nova Scotia. "**Weird and Wacky Plant Holders**- consists of hats, a bedpan, and a muffler among other things. **Peter Rabbit Garden** - veggies from the story are grown in the order they appear in the tale and a storyboard is placed with them to tell the story. **Pizza Garden** - ingredients are being grown for a vegetarian pizza to be made after harvest. Onions, peppers, tomatoes and herbs can be found here. " Posted July 24, 2002, 2002

Small-Scale Farming and Gardens in Urban and Rural Areas - Working Group, Humboldt University, Berlin

"Gardens and small-holders agriculture belong to the informal economy - newly rediscovered in the public discourse as a result of increasing joblessness. In the old society, yard and garden were indispensable parts of the oikos, as Otto Brunner called the 'whole house'. Still today gardens, small animal holding and self-subsistence agriculture belong to the domain of the home economy. Household and food growing constitute actually the primary, basic sector of the economy." Elisabeth Meyer-Renschhausen (In both German and English) Posted July 16, 2002

FAO Journal includes Urban Agriculture Articles

Food, Nutrition and Agriculture No. 29, 2001, includes articles such as "Cities of the Future: urban agriculture in the third millennium" and "Peri-urban agriculture in Delhi, India." "Farming, processing and selling food generates income for urban households and enables families to spend more on non-food items (e.g. transport, housing, school fees, health care), which can have an impact on nutritional status." Posted July 8, 2002

Nyanga Declaration on Urban and Peri-Urban Agriculture in Zimbabwe

"Urging local authorities to promote Urban and Peri-urban Agriculture in their cities, develop appropriate incentives and other policies necessary for its growth, mainstream urban food security within their operations and promote the collection and dissemination of information on Urban and Peri-urban Agriculture activities in their territorial planning areas." Posted July 3, 2002

Why Hawked Milk Can Save Your Baby

"Historical and scientific evidence shows that, after boiling, milk can actually save, not kill, your baby by providing essential nutrients. If boiling milk were ineffective as implied in the article, most Kenyans who each day buy raw milk, boil and consume it would be sick each day. And as we all know from our own day-to-day experience, we do not get sick from drinking chai with maziwa." Posted July 3, 2002

Urban Agriculture Study - Consulting Services - RFP

"The City of Vancouver Engineering Services is inviting proposals for Professional Services to complete an Urban Agriculture Study for the proposed sustainable community to be located on the south east shore of False Creek near downtown Vancouver. The study will be incorporated into the Official Development Plan to direct development of the site including public infrastructure, private development, and community facilities." Posted June 28, 2002

"Return of Lenin" (to a Swedish allotment garden) - a short film

"In 1917 Lenin passed through Stockholm on his way to the Russian

Revolution. Anna Lindhagen invited Lenin to the allotment gardens of "Barnangen" to show all its benefits. Lenin was totally unresponsive to this, - to poke in the soil was to prepare the ground for political laziness in the class struggle. The workers shouldn't be occupied, with gardening, they should rather devote themselves to the proletarian revolution. - " Posted June 17, 2002

City Farmer's Country Count

"Therefore City Farmer still has over 50 "countries" still to collect in order make sure everyone has heard about urban agriculture. Like stamp collectors we await the arrival of such rare finds as the Comoros(KM); the Holy See (Vatican City State)(VA); Kiribati(KI); Antarctica(AQ); and Western Sahara(EH)." Posted June 15, 2002

The Love Garden - Can love be found over a compost bin?

"Our first date was at the garden. Take-out Chinese at the picnic table. I had my head in a compost bin when he walked through the garden gate. 'Hello,' he said. I looked up and there he was. Rumpled but stylish New York, with a generous dash of West Coast outdoorsman (translation: fleece), and, I recoiled, a beard and moustache." Posted June 14, 2002

Urban Agriculture Now Includes Healthier Living

"The Americans are widening the definition of urban agriculture," Mr Wilson said. "They see it as part of promotion of better human health in cities, and one of the important answers to protecting the global environment. I will not be surprised to see urban agriculture become part of the US response to Japan's signing last week of the Kyoto Treaty on environmental protection," said Geoff Wilson, editor and publisher of **Urban Agriculture Online** Posted June 12, 2002

Urban and Agricultural Communities: Opportunities for Common Ground

"This new, Council for Agricultural Science and Technology (CAST) task force report, considers the changing role of agriculture in urban settings. The report frames "urban agriculture" in both historical and contemporary American society, providing a picture of geographic, demographic, and economic changes in rural and metropolitan life." ... "This clearly is an appropriate time to redefine agriculture in the context of an urban society. The wealth of knowledge associated with the wide array of agricultural sciences could be put to valuable use in helping to meet many of the challenges of urbanization." PDF file.
Posted June 9, 2002

Human-Environment Research Laboratory (HERL) Studies the Relationship between People and the Physical Environment

"The impact of the physical environment on human aggression has been well-established - crowding, high temperatures, and noise have all been linked to

violent behavior. Some scientists believe that it's because people living under these conditions suffer from something called chronic mental fatigue, which can make them inattentive, irritable, and impulsive - all of which can be linked to aggressive behavior. Exposure to green spaces, it has been shown, can mitigate the harmful effects of chronic mental fatigue, reducing aggressive behavior in the process."
Posted June 7, 2002

Growing Food, Healing Lives: Linking Community Food Security and Domestic Violence

"Women were proud of their new knowledge. Some residents had never previously gardened, assuming they wouldn't be able to succeed at it. The act of gardening itself became empowering, providing a "feeling of pride of eating from the garden something that I grew," as one resident put it. A Spanish-speaking resident also explained how important it was to learn that one could "have our own vegetables in a small space where we are living." Another woman said, "I like the classes. Learning things like making compost. I used to think it stinks, but now I love it!" Download the PDF file.
Posted June 6, 2002

Proposed Community Garden Legislation in New York

"After more than a month of behind the scenes negotiation, members of the new NYC Council will file legislation that, if passed, can protect community gardens from development. The legislation being proposed will look different from the law that was introduced in the last Council. It now focuses on a stipulation that would turn the GreenThumb program into an independent public/ private partnership to act as a land trust for the preserved gardens."
Posted June 3, 2002

The War Garden Victorious

This rare book (1919), about the USA food gardening program during World War I, is being republished chapter by chapter on the Internet. "The United States government strongly encouraged everyone to plant a garden to provide their own food so that food, transportation and other resources could be freed up for the war effort." - "The sole aim of the National War Garden Commission was to arouse the patriots of America to the importance of putting all idle land to work, to teach them how to do it, and to educate them to conserve by canning and drying all food they could not use while fresh. The idea of the 'city farmer' came into being."
Posted June 1, 2002

Old Cities/Green Cities - Communities Transform Unmanaged Land

"This report was developed out of a series of documents on urban vacant land by one of the leading gorups in the country dealing with this issue--the Pennsylvania Horticultural Society (PHS). Part 1 of the report addresses the challenges to urban vitality presented by vacant land; vacant land as a neighborhood resource; large-scale

greening systems; and the link between urban renewal and sprawl. Part 2 provides an in-depth look at some PHS programs. An appendix provides a list of contacts to the many Community Development Corporations active in the area of urban greening in cities throughout the United States." Posted May 29, 2002

Re-Vision Urban Farm

"Re-Vision Urban Farm is a project of Re-Vision House, aÊ shelter for homeless pregnant and parenting women and their children. We are a shelter-based, community supported urban farm growing organic produce and fish on reclaimed land which was once vacant lots." Posted May 23, 2002

Urban Agriculture and Community Food Security in the United States: Farming from the City Center To the Urban Fringe

The document advocates for policies that promote small-scale urban and peri-urban farming, and thereby prepare the next generation of urban farming leaders. The task is to increase public knowledge and support, in order to transform urban agriculture "from its cottage industry status into a major instrument against hunger and poverty." Posted May 23, 2002

E-Conference: Agricultural Use Of Untreated Urban Wastewater In Low Income Countries: 24 June - 5 July 2002

"The use of the urban wastewater in agriculture is a widely established practice, particularly so in urban and peri-urban areas of arid and seasonally arid zones. Wastewater is used as a source of irrigation water as well as a source of plant nutrients (such as nitrogen, phosphorus and potassium) and trace elements (K, Na, etc) allowing farmers to reduce or even eliminate the purchase of chemical fertilizer and of organic matter that serves as a soil conditioner and humus replenisher Lunven (1992) estimated that one tenth or more of the world's population currently eats food produced on wastewater (but not always in a safe way)." Posted May 23, 2002

Urban Agriculture Online - a new magazine

Geoff Wilson, editor and publisher of **Urban Agriculture Online** said he chose to launch the online magazine at the 'Dallas Urban Agriculture Symposium' because he saw it as the most important global event in urban agriculture in 2002. "Many countries have endorsed urban agriculture as most complementary food production that well meshes with rural agriculture. They are seeing it as an important response to the world's rapid urbanization of rural areas, desertification, pollution of air and water, and the possible impact of bio-terrorism." Posted May 21, 2002

Vancouver Landscaper Moves from Power to Push Mowers

"But there is this one big lawn spreading between 5.5 acres of townhouses, parking lots and perennial beds. The lawn area itself represents probably a quarter of the property. No one thought this lawn could possibly be maintained with reel push mowers on a weekly basis." Posted May 6, 2002

Walled Kitchen Gardens

"They were like an early version of supermarkets. Nowadays, our food system is global. Food is flown in from far away, which is widely regarded as unsustainable. Walled kitchen gardens succeeded in growing this food at home, all-year-round. By developing techniques and technology that we rely upon today, walled kitchen gardens were intensive food factories that spearheaded our industrial food system." Posted May 2, 2002

Chinese, Japanese, German, Swedish, English Allotment Garden Reports

"In Japan allotment and community gardening have been paid striking attention to during the last two decades. For example, the number of allotment sites has increased and allotment gardens were given a legal basis. After World War II the primary objective of allotment gardens was to obtain food. This changed to recreation and to improvement of urban environments later on." Posted May 2, 2001

Community Greens: Shared Parks in Urban Blocks

"Community greens are shared parks tucked away on the inside of residential blocks. They are collectively owned and managed by the neighbors whose homes and backyards, decks, patios, and balconies enclose the green.These secret gardens bring neighbors together as they care for and enjoy their community green." Posted April 21, 2002

Pigs in Streets of Dili, East Timor

"Asked how many pigs were wandering around Dili, Mr. Da Silva said he wasn't sure. 'They are hard to avoid at times, choosing to cross roads when they please, bringing traffic to a halt. Initially I thought they didn't have owners, but they do. And people know exactly which ones belong to them,' he added, without explaining just how." Posted April 17, 2002

A Taste of Urban Agriculture in Havana - Tara's Latest Update

"Mosquitoes are no laughing matter here in Havana. In fact, there are armies - with uniforms to boot - of people employed to rid Cuba of the dreaded Dengue Fever. These people patrol the streets with huge machines that look a lot like leaf blowers. ...The warriors will then enter the house and spray every inch with a terrible white chemical that smells horrible and that no one can identify - not even the fumigation warriors who brave the terrible white fumes without even a gas mask." Updated April 16, 2002

Urban Agriculture: An Overview

Prepared for 'Both Ends'- which supports inspiring environmental initiatives all over the world. "This report provides in very general terms the key characteristics of UA and the barriers that hinder its promotion. It also outlines some of the work that NGOs have been doing with respect to UA. The last section offers some

recommendations with respect to the role that NGOs can play in advancing UA." Posted April 14, 2002

Evaluating Voluntary Stormwater Management Initiatives in Urban Residential Areas

"In recent decades, stormwater runoff has emerged as an issue of major concern to water resource managers. Stormwater affects local waterways both in terms of the volume of runoff that is generated, and the nature of the pollutants that may be conveyed. Allowing stormwater to infiltrate in urban residential areas is one way of managing runoff at-source, and by doing so, preventing a wide variety of down-stream effects." (40,000 word Master's Thesis in PDF format) Posted March 29, 2002

Farm/Garden Land For Rent in Greater Vancouver

"The land is just off of River Road on the North Arm of the Fraser River. We are a 30 minute drive from Downtown Vancouver, (15 minutes if they are from the south end of Vancouver), as we are just off of the east/west connector." Posted March 28, 2002

Whose Garden Is It?

Governing Magazine/March 2002 - "Community gardens can help turn neighborhoods around. It's their very success that threatens them." - "The city accuses garden activists of being insensitive to the need for low-income housing; the activists say their views are being misrepresented. The city, says Aresh Javadi, director of a group called More Gardens, 'makes it sound as if it's housing versus gardens. That's wrong. It's both housing and gardens.'" Posted March 27, 2002

Food for Everyone Foundation

"Dr. Jacob Mittleider has spent decades teaching and growing all over the world, perfecting his incredible gardening techniques. Many organizations raise money to feed the hungry, however Dr. Mittleider lives by the profound maxim: "Give a man a fish, and he'll eat for a day; teach a man to fish and he'll feed his family for a lifetime." Because of this belief, Dr. Mittleider has dedicated his life to teaching people everywhere how to be self-sufficient by growing super high-yield gardens, even in small boxes or soil plots." Posted March 26, 2002

Urban Waste And Rural Farmers: Enabling Low-Cost Organic Waste Reuse In Developing Countries

"Farmers and animal husbanders in poor countries have acquired and continue to access urban organic wastes and to process and use them in various ways. Green wastes obtained from fruit and vegetable markets are used for animal fodder; food wastes from hotels, canteens and food processing industries are fed to pigs and goats; slaughterhouse wastes are processed for poultry feed"
Posted March 20, 2002

Common Ground Program & Mini- Ag Center (CGP) in

Kenya

"I was able to stop working away from my farm as a wage laborer in Mumiasi to work full-time tending my one-acre farm. After receiving training in Biointensive practices my wife and I converted our conventionally cultivated farm to one using double-dug beds. This enabled us to produce surplus vegetables for sale in local markets. The income increased four times what it was as a day laborer and I am a much happier person working for myself. As a result I have trained 530 other families in my Community" Posted March 20, 2002

Chapter 16 - Urban Agriculture: A Powerful Engine for Sustainable Cities

Just and Lasting Change - When Communities Own Their Futures, includes a 3000 word chapter by Jac Smit on Urban Agriculture. "People around the world are returning to farming in cities. As a Ford Foundation urban adviser in 1968 I found that people in Calcutta were producing one-quarter of the fish and vegetables being consumed there, using waste-water and solid waste. In many places today urban agriculture supplies between one-quarter and one-half of city dwellers total food needs." Posted March 10, 2002

References Relevant To Urban Agriculture

Here you will find reports on topics related to urban agriculture. Updated March 9, 2002

GIS-based Urban Environmental Resources Management and Food Security Project, Cagayan de Oro, Philippines

"The project will establish a GIS-based urban environmental planning system in Cagayan de Oro through a participative process. It will address the needs of the community in terms of improved solid waste management linked with urban food security. The target groups are the urban poor, particularly the garbage pickers at the landfill site, and the marginal urban farmers. " Posted March 6, 2002

RUAF Urban Agriculture Film

"This video on Urban Agriculture has been produced to facilitate a greater understanding of urban agriculture among policy-makers, urban planners, NGOs, sectoral organisations and other people who can make a contribution to the integration of urban agriculture into urban policies, plans and development programmes." Posted March 4, 2002

Sweat Equity: a Film

"Sweat Equity is the first film produced by the Metro Farming Film Project. The documentary focuses on community gardening activism that was occurring throughout the City of Los Angeles during the years following the 1992 civic unrest. Grassroots actions by local leadership and the sweat equity of community people made it possible to reclaim abandoned land to create urban gardens. " Posted March 4, 2002

Self-Sufficiency Plan for Copenhagen Suburb

"The Environment and Energy Centre (MEC) in Höje Taastrup (population 45,000), to the west of Copenhagen in Denmark, has developed a realistic plan to make the region self-sufficient in food. Double the percentage of garden owners who grow their own vegetables; Triple the number of allotments; Quintuple the number of people owning hens (5 per cent already do); Increase production of honey and strengthen bonds with nearby farms by getting more people to buy produce directly from them; or for people to buy their own animals and rent pasture from the farmers;"
Posted March 2, 2002

More Urban Agriculture Stories Can Be Found Here

Readers in the following countries have accessed our web site since February 12, 1996. We will be looking at our web stats every day to see what new additions can be made to this list.

News Flash ... August 2, 2004 ... "Burundi" and "East Timor" are the 194th and 195th countries to visit our web site since we began tracking visitors! (See City Farmer's country count.) Over 4 million hits were recorded on our site during the year 2003!

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Recognition Of Our Site

We have received lots of awards and are noted in many places. Visit the trophy room.

COMMENTS

What would you like us to add to **Urban Agriculture Notes ®** ?

Tell us about Urban Agriculture activities in your city.

revised, August 14, 2004

E-mail us at: **cityfarm@interchange.ubc.ca**

Mailing Address:
City Farmer - Canada's Office of Urban Agriculture

Box 74561, Kitsilano RPO,
Vancouver, B.C. V6K 4P4 Canada
Office Phone: (604) 685-5832

Garden Location:
Vancouver Compost Demonstration Garden
2150 Maple Street, Kitsilano, (6th and Maple)
Vancouver BC, V6J 3T3 Canada
Garden Phone: (604) 736-2250

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Cities Feeding People Program

In the mushrooming cities of the developing world, farming is a growth business. Figures from the United Nations Development Programme peg the number of urban farmers at about 800 million worldwide. Most of them are poor or middle class. They raise livestock and grow produce to feed their families and, where possible, to generate income. In the process, they recycle wastes, reuse water, and put idle land to productive use. Many governments now recognize the contribution urban farmers make to cleaner, healthier cities. Most, however, lack policies to integrate urban agriculture into sustainable urban management practices.

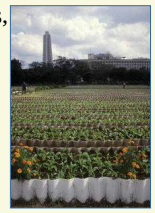
IDRC's Cities Feeding People (CFP) Program Initiative is trying to bridge that gap by supporting research and development activities that increase the food security and incomes of the poor while maintaining public health and a clean urban environment.

Through CFP projects, the Program Initiative is seeking to create a better understanding of the constraints faced by urban farmers who are often hampered by unfavorable local policies and limited access to resources. Women producers, in particular, face many obstacles. CFP also supports research that examines the political economy of urban agriculture, including access to credit and investment schemes, the role of UA in the recycling chain, and links with rural agriculture. (This site operates primarily in English)

For further information about Cities Feeding People, please refer to the links below:

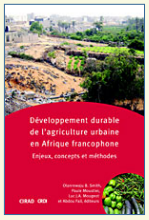
- **About us**
- **AGROPOLIS Awards**
- **UA in Canada**

POLICY BRIEFS: Urban Agriculture Policy Briefs for Local Governments in Latin America 2003



Raising awareness, mobilizing support, and strengthening capacities of municipal governments to implement urban agriculture programs and policies.

DÉVELOPPEMENT DURABLE DE L'AGRICULTURE URBAINE EN AFRIQUE FRANCOPHONE Enjeux, concepts et méthodes



Circle of Life: Organic Farming in Mexico

2003-07-04
Every two weeks in Guadalajara, in Jalisco State, Mexico, perhaps half a dozen farm producers retail organic foods and household cleaners at a tiny community market, in a friendly participant's yard. ...

Rosario's Urban Agriculture Program among top 40 projects to win the prestigious Dubai International Award for Best Practices

2004-07-18 *Best Practices*
Rosario's Urban Agriculture program has been selected among the top 40 Best Practices worldwide for improving people's living environment. The Municipality of Rosario and CEPAR who have been ...

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2004-08-15
McGill University and the Centro de Investigación en Gestion Urbana (CIGU) have embarked upon a global project to develop site plans and urban design that incorporates urban agriculture as a primary ...

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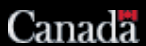

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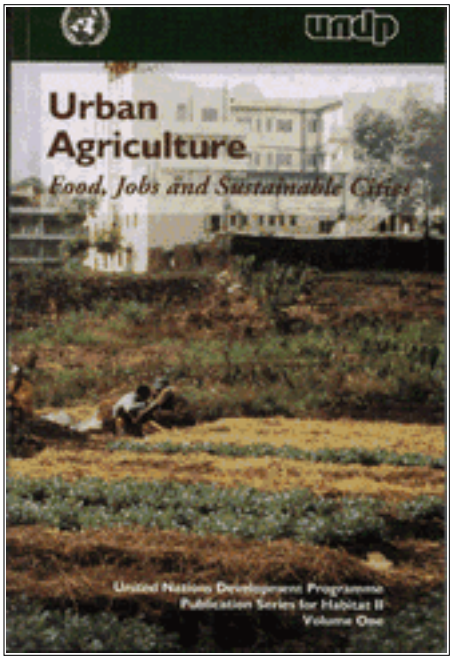
Urban Agriculture: Food, Jobs and Sustainable Cities



Urban Agriculture: Food, Jobs and Sustainable Cities
UNDP, Habitat II Series, 1996

Authors: Jac Smit, Annu Ratta and Joe Nasr
The Urban Agriculture Network

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Jac Smit is the principal author of the seminal book on urban agriculture, U A: Food Jobs and Sustainable Cities, UNDP 1996. The book is now in process of a major up-date and will be released soon by UNDP and IDRC.

Jac grew up in a professor's family with agricultural antecedents. By age twenty he

had worked in poultry, dairy, fruit, vegetable and ornamental horticulture production and been engaged in direct marketing in six of the United States.

He went on to take a technical degree in agriculture from SUNY and after defining his life objective as "ecologically sustainable cities" moved on to a master's degree in City and Regional planning at the Harvard Graduate School of Design.

As a professional city planner he carried this commitment to over thirty countries on five continents. In 1990 he switched from, urban regional planning with some agriculture, to full time urban agriculture. After a world study tour, visiting 20 countries, he founded The Urban Agriculture Network [TUAN]. TUAN today is the repository of the world's leading UA library and is linked to hundreds of UA organizations globally.

Is urban farming a marginal activity practiced for survival by the poor and a relic from rural habits, or is it a modern economic activity with major significance for food security, stable family incomes and a livable urban environment? That is the question explored by the book: **Urban Agriculture: Food, Jobs and Sustainable Cities**.

The book is based on exploratory trips made to over 20 countries in Asia, Africa and Latin America by the Urban Agriculture Initiative of the UNDP, and on extensive research and information gathering from diverse sources over many years. This 300 page book fills the information gap about urban agriculture.

For the first time one document presents the experience of urban farming in countries across Asia, Africa and Latin America:

- who the farmers are
- where they farm
- what the crops are
- the benefits and constraints
- the legislative, urban management and market environment and
- the history and current status of urban farming

Urban agriculture offers towns and cities the benefits of income generation, hunger reduction and nutrition improvement, environment enhancement and sustainable management. However, there are also risks. It can be environmentally degrading, and unhygienic if poorly practiced.

This book analyzes the current and potential benefits, costs and constraints of urban farming. Future steps are then suggested, based on an analysis of the lessons from current and past practices. The book makes extensive use of case studies [50], photos [63] and tables [20]. Appendices include further information on other readings and addresses of experts worldwide.

This book will be a useful tool for development agencies, NGO's, community organizations, government agencies, international agencies, research institutions,

agencies dealing with poverty, hunger, nutrition, urban management or sustainable development. It will help them get a clearer picture of the relevance and scope of urban farming within their objective, and help them define their strategy in urban agriculture. It is likely to become a core document in university courses.

Scientific American reviews Jac Smit's book in their June/96 issue
URBACULTURE: Cities of the developing world learn to feed themselves

Forward

Cities and Towns Visited by The Urban Agriculture Network, 1991-95

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21st Century Cities
What Would the World be Like in the 21st Century if Cities Were Nutritionally Self-Reliant? Paper delivered by Jac Smit in Marmaris, Turkey on April 20, 1996

International Sustainable Agriculture Issues Report
At the April 29, 1994 WSAA Brown Bag meeting, Jac Smit of the Urban Agriculture Network spoke about the increasingly important role of urban agriculture in sustainable agriculture.

Foreword

This book has four main purposes:

1. to present a comprehensive picture of urban agriculture in Asia, Africa and Latin America;
2. to define a distinct industry that needs to be recognized and treated as such;
3. to persuade leaders in government, non-governmental organizations, research institutions and other public and private entities to conduct research, support action projects and eliminate unnecessary constraints to the growth of the urban agriculture industry and
4. to foster a climate that empowers practitioners and the agencies that back them to fulfill the industry's potential for improving public well being and the quality of urban life.

The book reveals that urban agriculture has been overlooked, underestimated and underreported. It outlines the historical prejudices and biases against urban farming, which for the most part are either unfounded or obsolete. Actual problems that can result from ill-practised cultivation and animal rearing in urbanized areas are identified, as are the many benefits of well-planned and well-executed urban agriculture.

Additionally, the volume reviews the history and current status of urban farming in terms of its relevance for the future, describes some of the urban agricultural enterprises that exist in a score of countries and explores potential methods of promoting the urban agriculture industry.

Through extensive interviews and correspondence, it has become clear that urban agriculture has been underrated in all but a handful of countries and mostly overlooked by the international development community. During the 1980s, the industry was in a period of rapid growth which included a transfer of methods, particularly from Asia to Africa and Latin America. Nutritionists, energy specialists, geographers, urban planners, agriculturists and social scientists began to report on this growth at an unprecedented rate, each from his own point of view. This book is, we believe, the first effort to pull together their findings. We therefore consider it to be a "wake-up call".

As an industry, urban agriculture is closely linked to several urban, ecological, social and economic systems. It provides economic benefits for urban farmers and their communities and cities. It enhances the living environment and can improve efficiency in urban management. It contributes to better public health (if practised properly) and furthers social participation in the community. It can play an important role in reducing some types of hazards and in aiding the survivors of others.

Because of these multiple linkages and benefits, urban agriculture more than most other industries requires partnerships between public and private interests to achieve its potential. Yet urban farmers by and large believe that they are isolated pioneers without support. They have difficulty accomplishing what other industries consider routine, such as buying necessary inputs (seeds, fertilizer and tools), borrowing capital or buying insurance, acquiring a manual or obtaining instructions on how to produce a new product or crop or even protecting their activities against theft. Through solidarity and dissemination of knowledge, urban farmers should have a more secure foundation that ensures better returns for their efforts.

This volume focuses on urban agriculture in Asia, Africa and Latin America. It makes only occasional references to urban agriculture in Europe, the Middle East, the Pacific islands, the Caribbean and North America. This was a decision made at the outset because it was foreseen that the greatest potential benefits could be realized in the developing regions represented by the countries visited. However, the findings and conclusions of this document do refer to reports on other geographic areas where the information is available. It is important to note that some wealthy countries, including Japan and the Netherlands, have long been leaders in urban agriculture.

The intended audience for this book includes policy-makers, researchers, development agency staff, government agencies, non-governmental organizations and private organizations concerned with food security as well as those involved in agricultural production, processing and marketing; urban hunger and nutrition; micro-enterprise development; the urban environment and waste management. The priority audience is in the developing countries but includes international agencies and readers with related concerns in industrial countries. For instance, recent books on 'green' and ecological cities have chapters on urban agriculture, and it is hoped that this book will resonate with some of their readers. There is also considerable interest in urban agriculture among the supporters of sustainable agriculture.

Background

The findings and conclusions are based on field research conducted by UNDP consultants from The Urban Agriculture Network in 18 countries in Asia, Africa and Latin America during 1991 and 1992, supplemented by additional trips to several other countries, along with desk and library research that reviewed studies from the early 197Os through 1995. More than 300 interviews and more than 100 site visits were conducted with farmers, government officials and representatives of non-governmental organizations, community groups and research institutes. Important information was also obtained through visits to research and operating agencies of the United Nations and participation in workshops and conferences.

The book is thus not the work of one author or even a team, but has literally hundreds of committed authors: the members of The Urban Agriculture Network. The beginnings of the network date to early 1991, when UNDP/DGIP, with the technical support of the Urban Development Unit, launched this benchmark study of urban agriculture to provide a common base of knowledge on the issues, strengths, problems and concerns related to urban farming. By emphasizing a global field visit approach, UNDP enabled a network to form gradually, with the study authors initially acting as its central node.

Reading and using this book

Part I of this book outlines just how significant urban agriculture is and why its processes fit into the urban food and ecological systems. It provides an overview of urban farming today and in the past, including some success stories from different regions of the globe. Part II gives a detailed characterization of urban farming defining who the farmers are, where farming is undertaken, what crops are farmed and how, and which actors play a key role in the activity. Part III discusses the benefits of urban farming and the problems it can cause when poorly practised, as well as the constraints farmers face. Finally, part IV looks to the future to define a strategy for promoting urban farming throughout the world.

Various readers may wish to use this volume in different ways. Leaders of development agencies may be less interested than farmers in studying the many

examples of different urban agricultural enterprises. They may, however, wish at least to scan the case studies in parts I and II, which present snapshots of particular applications. Part IV, on the other hand, is addressed to their municipal, regional and global agendas and may be of less interest to practitioners.

Certainly farmers know all too well the information in the chapter in part III on the constraints facing urban agriculture. This book nonetheless can provide them with useful comparative information as well as serve as a source of ideas from other countries and regions. Perhaps a sense of belonging to a global community of fellow practitioners will emerge from their reading of parts I and II.

Some specialists will know far more than what can be found in this book on their particular area of interest; they may, however, be able to integrate that focused knowledge into other domains with which they are less familiar. A sanitation specialist, for example, may be surprised by the significant links of waste to the urban food system.

All readers will gain from part III, which contains chapters on the benefits, problems and constraints of urban agriculture. If a consensus can be found about what can and should be done, a new urgency will be created to break the shackles that are retarding urban agriculture's development.

As you read, keep sight of some of the broader implications of farming in the city: towns, cities and metropolises that are ecologically sustainable; an opportunity for the poor to become nutritionally self-reliant and to supplement their income; and a thriving industry that contributes to economic development. This is the promise that farming holds for urban areas.

Some public officials, business leaders, leaders of non-governmental organizations and other key individuals may already be persuaded of the merits of urban agriculture. It is hoped that this book will help convince others as well.

Cities and Towns Visited by The Urban Agriculture Network, 1991-95

The Urban Agriculture Network visited 18 developing countries between fall 1991 and spring 1992 during four study trips funded by UNDP. During the preparation of this report, the authors also visited cities in 12 additional countries for conferences, interviews or field observations; these cities are denoted with an asterisk (*). The towns and cities visited included a wide range of cultures, economies and climates.

EAST AND SOUTH ASIA

India: Bhatpara, Burdwan, Calcutta, New Delhi

Indonesia: Bandung, Bogor, Jakarta

Philippines: Cavite, Los Baños, Manila

Taiwan: Kaohsiung, Taichung, Tainan, Taipei

Thailand: Bangkok, Samut Sakhon

MIDDLE EAST

Egypt: Cairo*

Lebanon: Beirut*

EUROPE

France: Amiens*, Pads*

Germany: Berlin*, Frankfurt am Main, Freiburg im Breisgau*, Leipzig*, Zschortau*

Italy: Rome*

Netherlands: Amers Foort*, Amsterdam*

United Kingdom: Chatham*, London*, Manchester*

SUB-SAHARAN AFRICA

Côte d'lvoire: Abidjan, Agboville, Bingerville*, Dabou, Danane*, Yamoussoukrou*

Eritrea: Asmara*, Dubarwa*, Keren*

Kenya: Nairobi, Naivasha, Ngong

Senegal: Dakar, Louga, Saint-Louis, Thi&egraves

Tanzania: Arusha*, Bagamoyo, Dar es Salaam, Dodoma*, Lushoto*, Mehru*, Morogoro

Uganda: Kampala*

Zambia: Lusaka

SOUTH AMERICA

Argentina: Buenos Aires, Lomas de Zamora, San Isidro

Bolivia: El Alto*, La Paz*

Brazil: Curitiba, Rio Branco do Sul, Rio de Janeiro

Chile: Maipú, Santiago

Colombia: Bogotá, Cali*, Medellín*, Villa de Leyva*, Zipaquirá

Peru: Chosica, Lima, Villa El Salvador

CENTRAL AMERICA AND THE CARIBBEAN

Haiti: Port-au-Prince*

Mexico: Coyoacan, Culhuacan, Mexico City

Nicaragua: Managua, Nagarotte

Panama: Col&oacuten, La Chorrera, Panama City

NORTH AMERICA

Canada: Ottawa*

United States: Baltimore*, Chicago*, New York*, Philadelphia*, Providence*, San Francisco*

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Urban Agriculture Notes

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The Urban Agriculture Network (UAN) President's Annual Report 2001/2002

Submitted by,
Jac Smit, President
URBANAG@compuserve.com
The Urban Agriculture Network, Inc.
October 10, 2002

I. INTRODUCTION

October 2001 to September 2002 was a period of steady growth in the field of urban agriculture and one that particularly increased the public's attention to the field. As one of the first organizations devoted to urban agriculture, UAN incorporated as a 501c.3 in 1992, benefited from this new awareness even as it contributed to the increase. The Network continued its key role as a global clearinghouse for information related to urban agriculture, and expanded its role of providing policy advice to key decision-makers, carrying out project and program evaluations, supporting education and training projects and providing material for diverse publications and the media. However, UAN has not yet been able to establish a sound financial base to support its activities and its vision for the future.

II. THE UAN VISION

UAN views its major role as that of coordination and assistance to a network of organizations working in urban agriculture-- international agencies, national and local governments, non-governmental organizations (NGOs), and other local and national bodies working for the development and effective implementation of urban agriculture production, processing and marketing programs. UAN provides training and materials to the staff of organizations that serve the poor in developing, industrializing and developed countries worldwide.

As a clearinghouse for new ideas and information, we define urban agriculture to

encompass urban and community planning, landscape design, sanitary engineering and environment improvement, as well as food security and sustainable agriculture from the city center to the urban fringe.

The four sets of key activities of UAN are:

- serving as a global clearinghouse for urban agriculture and developing partnerships with concerned organizations;
- providing policy advice, project design and evaluation with regard to urban agriculture;
- providing education and training in the field of urban agriculture, including publication of books and articles.
- Advocating for urban agriculture, sustainable urbanization and locally-based food security to international and national development organizations, professional organizations and the media

III. GLOBAL CLEARINGHOUSE

In 2001/2002, UAN expanded its existing global clearinghouse activities as well as providing technical support for both the 2002 World Food Summit [WFS/fyl] and the 2002 World Summit on Sustainable Development (WSSD).

We organized and chaired the annual meeting of the Support Group for Urban Agriculture [SGUA] in New York. And we participated in several of the activities of the Resource Center for Urban Agriculture and Forestry [RUAF]. These linked organizations, of which UAN is a founder in 1992 and 1996 respectively, now have over 50 members participating in the SGUA listserv and nine information centers in China, India, East & West Africa, The Middle East, Latin America, North America and Europe.

As of July 2002, our Network of corresponding members internationally, with an interest in urban agriculture and related topics, totaled over 7,500 members from over 80 countries, about half having organizational relationships. Our library is the largest collection of documents exclusively related to urban agriculture in the world and is available for study at our offices. Over 3,500 of our documents are listed at www.ruaf.org and a small number can be found at www.cityfarmer.org.

Resource Center for Urban Agriculture and Forestry [RUAF] Funded Activities

UAN has been cooperating with the Resource Center for Urban Agriculture and Forestry (RUAF) and partners, based in the Netherlands since 1999. UAN has received funding from RUAF to carry out the following functions:

1. preparing a database of documents related to urban agriculture;
2. providing a question and answer (Q&A) service in the field of urban agriculture;
3. providing an annotated bibliography of important works related to urban agriculture;

4. representing SGUA and RUAF to U.S. and international agencies located in Washington, D.C., and New York City, and contributing to conferences, radio and TV and diverse publications,
5. contributing to a global list of urban agriculture expertise
6. carrying out an assessment of urban agriculture in the Middle East and North Africa, which will have as one product a book on the subject in three languages.

Database Project

In early 2001, UAN completed the database project that resulted in the computer inputting of more than 3000 document entries, from newspaper clippings to articles and books, in 16 stipulated fields related to urban agriculture, with brief statements and cross-referencing of each entry.

UAN prepared an annotated bibliography of over 300 entries for SIDA in partnership with RUAF. This bibliography provides a summary of some of the most significant documents related to urban agriculture that have been published in recent years. The database and annotated bibliography are now on-line at www.ruaf.com and accessible at our offices. Both are being expanded.

Q&A Service

The Question and Answer Service continued to be carried out throughout 2001/2002 but at a reduced rate. During the six month period from March to September 2002, responses were made to 32 inquiries- 8 from Africa, 5 from Asia/Australia, 3 from Latin America, one from the Middle East, 4 from the Europe, 7 from North America and 4 from other sources. Queries have sifted from requests for 'how to produce' to how to enable, empower, survey and advocate. More questions are being received from editors, reporters, producers and researchers as we attract more attention to the growing field.

Representation

During 2001/2002, UAN continued its work of representation for SGUA and RUAF in the United States with national Government agencies, such as the USDA and USAID, with non-profit organizations, such as CARE and SAVE, and with advocacy groups such as the Food Security Advisory Committee (FSAC) and the Congressional Hunger Center.

With regard to international agencies, it continued to be a strong voice for farming in the city at the World Bank, UNICEF, UNDP, the Inter-American Development Bank, WHO, FAO and many others.

Most important was UAN's work in providing background materials on urban agriculture to the World Food Summit (WFS/fyl) held in Rome in June 2002, and the World Summit on Sustainable Development (WSSD), held in Johannesburg, South Africa, in August/September 2002.

For the World Food Summit, President Smit as one of the only voices stating the importance of urban agriculture during meetings held with high-level US Government officials as part of the Food Security Advisory Committee which reports to an interdepartmental group headed by the Vice President. The committee's work was a significant element in the US policy at the Summit.

For the WSSD, UAN prepared a paper of case studies covering urban agriculture activities from around the world that were published as part of a special issue of the RUAF magazine, Urban Agriculture, disseminated at the Summit. In addition, President Smit carried out activities in July and August 2002 to bring together various voices for urban agriculture from both the South and North, as well as from academia and practitioners in the fields of sustainable agriculture, the environment and food security at the conference in South Africa.

Other Clearinghouse Associates

President Smit also has been an active participant in the annual meetings and activities of the Consultative Group on International Agricultural Research (CGIAR). He assisted in drafting the proposal for the System-wide Initiative for Urban Agriculture [SIUPA] which has active participation by eight research centers with 40 sub-centers. And he has contributed to the pending system-wide Urban Harvest project. That group has been instrumental in developing the concept for a Global Conservation Trust to assist seed gene banks around the world, which was presented at the Johannesburg World Summit on Sustainable Development held in August/September 2002.

Partnerships

UAN is active in several organizations promoting urban agriculture including: Community Harvest, serving the city of Washington: Urban Strategies, in Philadelphia; the MidAtlantic Food and Farm Coalition, serving eight east coast USA states; The Community Food Security Coalition, national USA; American Community Gardening Association, national; AGUILA, Latin America; Society for International Development, global; and more.

UAN has developed partnerships with related organizations in the fields of agriculture, urban development, nutrition and health, the environment, forestry, waste management, micro-enterprise, community development and women's development. These partnerships supplement UAN's expertise in urban agriculture globally. Partnerships with City Farmer in Canada, and the International Partnership in Sustainable Agriculture continue to flourish. In addition, in 2001 an affiliation was made with Geoff Wilson who has established an Urban Agriculture Network branch in Brisbane, Australia. We are partnering with the Market Basket Foundation in Nigeria to establish an information service in Anglophone West Africa.

In July 2002, the Network was contacted by the non-profit organization, Group for Environmental Monitoring (GEM), in the Republic of South Africa to serve as its North American partner in carrying out the Metro Farms project with Canadian aid

assistance. For the past two years UAN has supported the national Center for Agricultural Science and Technology (CAST) in a wide ranging study of urban agriculture in America which climaxed in a conference in Dallas Texas May 19 to 22, 2002, at which Jac was a featured speaker. We recently met with their Washington office the to discuss opportunities to work together. This organization has a membership of 37 scientific organizations (with 173,000 individual members), and of 100 non-profits and 75 corporations and cooperatives, encompassing most of the leading agricultural scientists and agricultural institutions in the United States and many extension agents and representatives of relevant U.S. Government agencies.

In the area of food security, UAN has been active with the Community Food Security Coalition (CFSC). CFSC is an U.S. group founded in 1997 that now has a corporate membership of 600. President Smit is a member of its policy committee and was a major contributor to its 2002 publication, **Urban Agriculture and Community Food Security in the United States: Farming from the City Center to the Urban Fringe**, along with associate Joe Nasr. CFSC has its main goal to ensure that low-income families are empowered to achieve food security. It has made a number of presentations to the U.S. Congress and U.S. Government agencies.

UAN a founding member of Agriculture in Relief and Transition (ART) which is the leader in devising efficient agriculture-based programs to enable refugees and displaced persons to produce, process and distribute fresh healthy food to the temporary settlement.

Finally, UAN is continuing its relationships with faith-based organizations that have included urban agriculture in their global charity programs. The longest such relationship has been with the United Methodists. UAN also continues to participate with the Catholic Church and with the Lutherans in these types of activities.

Thus UAN is expanding its base of partnerships from the local to the global level so as to increase the influence of its clearinghouse functions to spread new ideas regarding urban agriculture throughout the world.

Media:

In 2001/2002, UAN continued to receive a number of requests from the media, from newspapers, radio, and television, in addition to the inquiries to the Q&A Service. With regard to newspapers there have been an increasing number of requests for interviews from papers in secondary cities, such as Birmingham, Alabama, and Rochester, New York), as well as continuing requests from The New York Times, The Los Angeles Times, The Washington Post and the major newsmagazines. With regard to radio, President Smit made several presentations on the Saturday Metro Farm program, as well as interviews with regional broadcasting systems throughout the U.S. UAN contributed to a CNN special on sustainable cities [urban agriculture in Shanghai segment] and a Canadian TV program presenting inner city projects from coast to coast. We advised RUAF in producing a video.

IV. POLICY ADVICE, PROJECT AND PROGRAM EVALUATION, CONFERENCES

Besides the global clearinghouse and partnership activities discussed above, UAN was active in 2001/2002 in a number of activities to provide policy advice and project and program evaluation, as well as making formal presentations to a series of conferences.

Policy Advice

The Urban Agriculture Network is providing policy advice to a number of national governments and to international organizations, including the UNDP, the World Bank, UNFAO, UNICEF, CARE International, and IDRC of Canada. It has advised staff members U.S. Congressmen. The advice given to the World Food Summit through the Food Security Advisory Committee and to the World Summit on Sustainable Development, in addition to the work of the CFSC with the U.S. Congress. Through partners we have advised the cities of Philadelphia, Vancouver, and Baltimore, and influential not for profits such as the American Farmland Trust and the American Institute of City Planners and, as above, CAST.

Project and Program Evaluation

UAN has been active in project and program evaluation. With regard to national governments, the Network has advised the UN Commission on Human Settlements (UNCHS) projects in Madras (India), Accra (Ghana) and Dar es Salaam, Tanzania regarding the inclusion of urban agriculture. UAN was also a participant in the evaluation of urban agriculture and vegetable production activities of GTZ in Tanzania that led to a major restructuring of that program.

The primary new activity in 2001/2002 was as a consultant to the TACONY Philadelphia Brownfields Project. In September 2001, President Smit was contacted by Alan Hunter of Urban Strategies on behalf of the Tacony Business Association in Philadelphia regarding UAN's participation in a project to redevelop a brownfield at the Metal Bank riverfront site. The redevelopment would include a "Living Earth Classroom" and state of the art mushroom production. The project is partnered with the Fleisher Art Institute and the Stroud Water Research Center and has funding from the owner.

A small but significant consultancy has been our contribution to the design of an another waterfront redevelopment project including urban agriculture at its core, South-East False Creek Urban Agriculture Study September 2002, by the Holland Barrs Planning Group, in Vancouver. This project hopefully will become a model of best practice.

Conferences

In addition to the activities listed above with RUAF, including preparation of materials to the World Summit on Sustainable Development, President Smit made a

series of formal conference presentations during 2001/2002. They include:

- Community Food Security Conference in Santa Fe New Mexico, a Short Course with the Food Project of Boston on planning for urban agriculture in low-income communities,
- American Community Garden Association (ACGA), held in Salt Lake City, Utah in September 2001- presentation regarding policy requirements of urban agriculture;
- CAST's Urban Agriculture Symposium in Dallas, Texas- May 20-22, 2002- Presentation regarding urban agriculture and community development;
- Wilson Center of the Smithsonian Institution- July 25, 2002- Forum on "Reducing Poverty and Strengthening Growth: The Urban Perspective"- Presentation on food security for cities;

In addition, President Smit was an active participant in the annual conferences of a number of partnership organizations, including:

- RUAF annual meetings of July 2001 in Dakar, Senegal, and of April 2002 in Appeldorf The Netherlands;
- Community Food Security Coalition (CFSC)- Fifth Annual Conference held in Washington, D.C. in October 2001- "Taking Back The Food System: Strategies for Healthy Food, Farms and Communities"- participation in workshops;
- American Community Gardening Association (ACGA)- annual meeting held in New York City in July 2002- entertained French visitors.

V. EDUCATION, TRAINING and PUBLICATION

The third major emphasis of UAN is education and training, including the publication of books and other materials to further knowledge of urban agriculture and its potential. UAN has been a pioneer in the preparation of materials regarding urban agriculture for the use of college and high school students. It was active in the startup of an urban agriculture project at Wilson High School in Washington, D.C. and has continued to participate in this and other similar activities at the secondary school level. In addition, President Smit has lectured on urban agriculture at a number of universities, including Princeton, Rutgers, the University of Virginia, the University of Maryland, the University of California at Berkeley, George Washington University and the University of the District of Columbia, Training

With regard to formal training, UAN has worked with Garden Resources of Washington [GROW] in the preparation of a training course for volunteers in urban agriculture as part of AMERICORPS (the U.S. domestic Peace Corps). In Europe, UAN assisted associate Jorge Zapp in a media/training project in Bulgaria. In the Middle East, UAN worked with associate Joe Nasr in the June 2001 MENA Workshop which provided materials on urban agriculture projects in seven countries of the region to its participants, as well as discussions of the best ways to design and carryout such projects. In West Africa, it worked with ATLAS to design and conduct a training workshop on urban agriculture in Abidjan, Ivory Coast.

On a general level, UAN has developed an active relationship with the Institute for Support of National Agricultural Research (ISNAR) with its principal office in The Netherlands. ISNAR carries out training courses for national agricultural research centers in many countries. Thus there is an opportunity to advise national officials directly.

In early 2002, UAN prepared a policy brief on urban agriculture for the Institute. In recent months, it has been in discussion with it regarding providing assistance in its training courses in the areas of food security and emergency agriculture, as well as women in agriculture and municipal administration with regard to urban agriculture. It is intended that these discussions will lead to joint training exercises.

Publications

Most importantly, UAN is in the process of preparation and publication of the second edition of its book, **Urban Agriculture: Food, Jobs and Sustainable Cities,** with the UNDP. The first edition, which came out in 1996, has been called the first substantial contribution in the field of urban agriculture, and has been a best seller throughout the world. Preparation and editing of the second edition have been completed, and negotiations for publication with the UNDP are expected to be finished soon. IDRC of Canada has agreed to bear some of the publication costs. In addition, serious interest is being shown by commercial publishers for the publication of French and Spanish editions of the book. Thus it appears that the second edition will carry on and further the favorable publicity achieved for UAN by the first edition. In addition, during 2001/2002, President Smit has contributed to other books, including:

- a chapter entitled "Urban Agriculture: A Powerful Engine for Sustainable Cities", as part of "Just and Lasting Change: When Communities Own Their Futures" Carl Taylor and Daniel Taylor-Ide, editors (Johns Hopkins Press: 2002
- a chapter in a community self-help book entitled "Urban Agriculture in Cities in the 21st Century";
- a major contribution, along with associate Joe Nasr, to the report "Urban Agriculture and Food Security in the United States: Farming from the City Center to the Urban Fringe", released at the end of March 2002 by the CFSC Urban Agriculture Committee of which they both are members.

Further, Associate Nasr is working on a book for RUAF based on the results of the June 2002 MENA Workshop mentioned above.

Thus participation in publications continues to play a major part in UAN's education and training initiative. Further publications are expected in 2003.

VI. HOUSEKEEPING MATTERS/OFFICE

It is important to report that UAN moved its office in September 2001 from Washington, D.C. to Silver Spring, Maryland, near to the metro station. The new office provides a greater amount of space at a lower rent, permitting the more

efficient arrangement of files and of UAN's unique collection of documents related to urban agriculture and more space for visiting scholars.

VII. PROGRAM FOR THE NEAR FUTURE

For the near future, UAN plans to continue its role as the premier clearinghouse for information regarding urban agriculture and as a source of new ideas and training in the field. It will also continue and expand its partnerships with like-minded organizations to carry out the clearinghouse role, and to provide training and program and policy advice to decision-makers in international organizations, national and local governments and to NGOs.

The importance of urban agriculture is becoming recognized as an important element of programs for not only food security, but also for sustainable urban development and efficient provision of the necessities to low-income families. UAN wants to expand its central coordinating role in making urban agriculture a reality throughout the world.

The Urban Agriculture Network: 1999 Activity Report

By Jac Smit
The Urban Agriculture Network

The Urban Agriculture Network (TUAN) is a non-profit corporation [IRS Section 50l (c) (3)] located in Washington, D.C. It was founded in 1992 to serve as a focal point and research center for the promotion of urban farming, with an emphasis on cities in low-income countries and on low-income communities everywhere.

The Network was founded in response to the increase of persistent hunger, as differentiated from cyclical hunger caused by drought or natural disasters, in urban areas in both poor countries and rich countries. Agriculture in urban and peri-urban spaces provides low-income families with the possibility of food security through physical access, and through opportunities for both jobs and microenterprise. It is also a response to the degradation of the environment in cities throughout the world. Successful urban agriculture can lead not only to food security for the poor but to the enrichment of the overall urban 'environment for living', through an increase in food and fuel production within urban and peri-urban areas. Thus, urban agriculture can ensure a stable, healthy food supply, while contributing to environmental justice and sustainability.

TUAN recognizes that urban areas contain a mixture of agricultural and non-agricultural activities and that modern urban expansion has blurred traditional rural-urban distinctions as densities of cities became lower (more land for crops) and rural-urban interactions have grown more complex. This process manifested itself in a growing diversification and commercialization of agricultural activities, and in inflows of investment into specialized agricultural activities in urban areas.

Urban agriculture enhances food security and nutrition for the least economically stable by improving access to food that has higher levels of essential micro-nutrients and protein, at lower costs. It reduces poverty by placing opportunities for jobs and small-scale businesses within low-income communities. Metropolitan intensive agriculture mitigates sprawl by putting the most fertile and resource rich areas into a permanent or long-term open space use at no cost to the taxpayer. This is possible because urban agriculture typically produces many times more food per acre than rural agriculture, and its products are sold for a higher price to the producer and without high transport costs. Urban agriculture closes nutrient loops that are presently open by converting urban waste into food and brownfields into gardens.

Food for persons living and working at home in rural areas can be produced there, and a substantial share of the food for families living in urban areas can be produced near their homes in the same manner. The improvement of such a non-traditional system in order to enhance food security is one of the main objectives of TUAN. In North America, the average food item on a store shelf has traveled 2,000 kilometers and has cost eight fossil-fuel calories to deliver one food calorie. In contrast, one report has shown urban production of perishable foods in central Europe to deliver eight food calories with the consumption of one fossil food calorie. In many, if not most, developing countries neither refrigerated road or air transport of food is feasible.

In short, urban agriculture is primarily concerned with seven specific matters:

1. The transformation of an area from rural to urban farming practices ahead of actual urban physical expansion;
2. The efficient use of vacant and under-used land at the urban core and within built-up areas;
3. The increase in individual and community food security within urban neighborhoods and urban regions
4. The generation of jobs and small enterprises in urban areas;
5. The reuse of urban waste for food, fuel and greening;
6. The greening of the city through tree-planting, community gardens and other such landscape uses; and
7. The expansion of the sense of community in urban areas.

The Network recognizes these multiple dimensions of urban agriculture, and supports policies that address these various aspects. It is carrying out seven key activities to promote these policies on a worldwide basis, taking full advantage of the increase in electronic communications via e-mail/internet, fax and radio.

Firstly, as the term "Network" implies, TUAN is developing a list of members internationally with an interest in urban agriculture and related topics. As of early 1999, it had over 6000 members from more than 80 countries in its data information file. TUAN is constantly both sending and receiving information from these sources. In addition, the Network is affiliated with a branch in Brisbane, Australia, [East Asia] and is working on the establishment of an Anglophone West Africa network and a Middle East/North Africa network.

A Question and Answer Service, which is now averaging 100 inquiries a month (increasingly via E-mail), supplements this primary role as a global clearinghouse. TUAN is a founding member of the Support Group on Urban Agriculture (SGUA) and of its web server network, linking some 30 development organizations. It also contributes regularly to the primary internet site on the subject, City Farmer (www.cityfarmer.org).

The role as a clearinghouse has been enormously enhanced by the publicity generated through the 1996 publication, on behalf of the UNDP, of The Network's book, **Urban Agriculture: Food, Jobs and Sustainable Cities**. At 328 pages, eight appendices, 63 photos, 50 cases, 15 figures and 19 tables, it has been called the first substantial contribution to the field of urban agriculture. The UNDP has agreed to fund a second edition in 1999.

In addition, the Network has been active in writing and promoting articles in the media on urban agriculture. Among others, it has had articles by its President Jac Smit published in **World Hunger Year** and Joe Nasr and Annu Ratta in the **African Urban Quarterly**. Mr. Smit has been interviewed on the radio at the **BBC**, **Voice of America**, at **Radio Saudi Arabia** and at several stations in the United States. The work of TUAN has been mentioned on the front pages of T**he Christian Science Monitor** and **The Philadelphia Inquirer**, and in **The New York Times**.

Secondly, TUAN is developing partnerships with related organizations in the fields of agriculture, urban development, nutrition, the environment, health, micro-enterprise, community development, and family and women's development. These partnerships supplement TUAN's expertise in the areas of information, policy, management, training, research and the organization of urban agriculture globally. Such partnerships have already been concluded with City Farmer in Canada and the International Partnership in Sustainable Agriculture.

Thirdly, the Network has been providing policy advice on urban agriculture to politicians in a number of countries and to several international organizations (including the World Bank, UNDP, UN/FAO, UNICEF, CARE International, IDRC of Canada and GTZ of Germany). It has advised members of the U.S. Senate and U.S. House of Representatives and their staffs on the general issues. It has counseled the Florida House project on urban agriculture in Sarasota and is an active member of the national Community Food Security Coalition.

Internationally, in addition to having co-founded the SGUA in 1992, the Network has advised the UNCHS Sustainable City Projects in Madras (India), Accra (Ghana) and

Dar es Salaam (Tanzania) regarding the inclusion of urban agriculture. It was active in advising the External Review Committee of the CGIAR system on integrating urban agriculture into their work program. TUAN organized and participated in the first meeting of the steering committee of the Global Initiative for Urban Agriculture, held in 1997 in New York. It also organized and participated in two workshops at the UNDP International Conference on Governance at the UN General Assembly. President Smit gave a workshop on urban agriculture in Sub-Saharan Africa to World Bank staff which has been published as Paper No. 11 of "Building Blocks for Africa 2025". At the Global "City Summit" in Istanbul in 1996, TUAN managed a workshop with participation for all six continents.

Fourthly, TUAN has assisted other organizations with conference planning and management, and with project design. The staff of The Network assisted IFPRI in the planning, management and assessment of a major global conference on "2020 Vision for Food, Agriculture and the Environment". President Smit participated in a Workshop on Urban Agriculture in La Paz, Bolivia, which led to the organizing of the Latin America Research Group "AGUILA". With the Economic Development Institute at the World Bank, TUAN facilitated a program design workshop on urban agriculture. In the same year, Joe Nasr organized a session at the conference of North American and European planning academicians, the first ever. TUAN has recently managed a training workshop for Catholic Relief Services in the area of food self-reliance for post disaster settlements. In Parana, Brazil, we assisted the UNDP in a workshop on Rural-Urban Links.

Africa has been a particular focus. CARE International is being advised by Annu Ratta on the inclusion of urban agriculture components in Zambia, and assistance is also being provided to projects in Senegal and the Ivory Coast. In Senegal, food security is being included in an eco-village project.

Fifthly, the Network has taken a significant role in urban agriculture education. During 1997 its staff presented lectures at Princeton, Rutgers, the University of California at Berkeley, the University of Virginia, George Washington University and at the University of the District of Columbia. In addition, President Smit was a featured speaker at annual conferences in Toronto, Canada, in Hartford, Connecticut, and in Brooklyn, New York. The Network was also active in the start up of an urban agriculture project at Wilson High School in the District of Columbia. In Baltimore we assisted Parks and People and Save a Neighborhood in an eight-part training for centre-city vacant lot commercial agriculture. Further, TUAN prepared a proposal for training agriculture extension specialists and community leaders for SARE/USDA.

Sixthly, TUAN is providing evaluation and training in the field of urban agriculture. It participated in a month-long evaluation the urban agriculture and vegetable production activities of the German Aid agency GTZ in Tanzania. With ATLAS, it designed and conducted a training workshop in Abidjan, Ivory Coast. In the United States, The Network advised in a training course for volunteers in urban agriculture for Americorps (the domestic peace corps) along with GROW, Garden Resources of Washington. In Europe, the Network is assisting Advisory Council member Jorge

Zapp in a media/training project in Bulgaria.

Seventh, TUAN is in 1999 expanding into two new areas:

. Emergency Agriculture: as a response to disasters and crises. We are a founding member of ART [Agriculture in Relief and Transition]. ART is leading the way in devising efficient agricultural food-based programs to enable refugees and displaced persons to feed themselves.

B. Brownfields Recycling: Cities constantly generate decay near their centers at the same time as new growth sprouts at their edges. At present Chicago has 70,000 vacant lots. Near these vacant lots [brownfields] are low-income residential areas. TUAN is working with individuals and organizations active in this field to harness food production to turn brownfields green and feed low-income city families.

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Urban Agriculture Notes

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What Would the World be Like in the 21st Century if Cities Were Nutritionally Self-Reliant?

The prospect for Urban Agriculture

By Jac Smit, President
jac smit
The Urban Agriculture Network
Washington DC, USA
(Copyright 1996)

This is an excerpt from a paper (30 pages) presented at a Global Roundtable in Marmaris, Turkey [UNDP & UNCHS] on April 20, 1996. The Table of Contents follows the excerpted passages.

I. Introduction:

The past 20 years have witnessed a reversal of a 150-year trend towards greater and greater separation of human settlements from the sources of their food production. As our cities grow larger they are producing a greater share of their food demand. And a greater share of their citizens are becoming active in food production.

At the time of Habitat II (June, 1996) it may be useful to consider the prospects of: the Earth Summit, the Social Summit, the Population Summit, the Women's Summit and the Food Summit within the prospect of cities feeding themselves rather than the more familiar symbiotic relationship in which food production is rural and cities are industrially based.

At Habitat II each official delegate will receive the book: **Urban Agriculture: Food, Jobs, and Sustainable Cities**. Among the more surprising findings of this five-year UNDP supported study are these:

- During the period 1970 to 1990 in Dar es Salaam District and in Greater Moscow the share of households engaged in food production increased from one-in-five to two-in-three.
- In Argentina from 1990 to 1994 the number of participants in the Pro Huerta [community agriculture] Program increased from 50,000 to 550,000, and the institutions supporting it increased from 100 to 1,100.
- During the period 1990 to 1994 the area devoted to urban agriculture in Harare, Zimbabwe [as measured from aerial photographs] increased by a factor of two.

Studies by the United Nations University, the United States Department of Agriculture, Canada's IDRC, ATSAF in Germany, CIRDAP in Bangladesh, AVRDC in Taiwan, and many Universities from Ithaca to Pretoria and Tokyo to Buenos Aries are reporting that urban food production is growing more rapidly than urban population.

As we consider a dominantly urban Earth early in the next century, in a world with less land and water per-capita, the return of agriculture to where we live presents us with a new paradigm.

What if "waste is food" and sewage and garbage were prime inputs to food production? What if the urban landscape were edible? What if vacant, waste land in cities were productive and enhancing the environment for living? What if urban areas were increasing biodiversity rather than diminishing it?

II. One Scenario of the 21st Century City:

On every continent, in rich and poor countries, cities are de-densifying. Communications and transport technology are making a contribution to the replacement of the 19th century "industrial" 'gridiron' and 'core-and-corridors' patterns of urbanization. The replacement is a 'nodes-and-links' network pattern. This pattern is much looser and intrinsically allows for a closer fit between man and biosphere. We have applied many negative labels to this transformation of human settlements: sprawl, edge city, urban decay, and urbanization. Too few have recognized a metamorphosis with beneficial possibilities.

The basis of this brief scenario is the concept of the human settlement as a ecologically closed-loop system -- closing the nutrient and carbon loops -- in which all waste is transformed into food, green, biodiversity, and recycled products. It is a scenario that has a planetary impact of reducing the land and water devoted to food production, in the next 40 years, by one-third while the population of the Earth increases by two-thirds. It contributes to the restoration of the deserts and expansion of the rain forests while reintegrating urban families with nature.

The scenario accomplishes these ends by increasing the intensity of production of fruit, vegetables, fish, poultry and small livestock by a factor of four to six and integrating this production within human settlements. A world is envisaged where

both manufacturing and agriculture are distributed equally between urban and rural settings. A world in which food systems and settlement systems are more closely integrated.

The urban landscape of 2035 may have the following characteristics:

- coasts, riversides, are wetlands devoted to agriculture and recreation,
- areas of steep slope, land over aquifers, and areas of expanding clays and materials valuable for building material are devoted to agriculture,
- institutional land [education, peace keeping, research, culture] includes food production on its peripheries,
- utility and transport lands [high voltage electric lines, highway verges, air and sea ports, natural gas ROWs are predominantly devoted to agriculture,
- high and low income residential communities commit a substantial share of their open space to agriculture,

All of these agricultural areas are 'ecological regeneration' zones which transform waste into food and biodiversity.

The characteristics of the 21st century city with this more productive land use pattern is one with fertile soil contributing to increased biodiversity and a major shift towards being a green and healthy city. This eco-city is already evolving. We just haven't noticed. And too often our policies and investment have been hindering its emergence.

IX. Conclusions:

Many cities are taking up the banner of sustainabilty. This requires that these cities participate in a national and global resources conservation effort. This paper presents a scenario and trend data that suggests that cities can be transformed from being only consumers of food and other agricultural products, into important resource-conserving, health-improving, sustainable generators of these products.

The relationship between urban agriculture and resources can be described as being three-pronged.

- First, some urban by-products, such as waste water and organic solid waste, can be recycled and transformed into resources or opportunities for growing agricultural products within urban and peri-urban areas.
- Second, some areas of cities, such as idle lands and bodies of water, can be converted into intensive agricultural production.
- Third, some other natural resources, such as energy for transportation and cooling, can be conserved through urban agriculture.

Urban agriculture in Africa, Latin America, North America and Europe is growing [1980s] more rapidly than population, urbanization or the economy. The benefits to urban environments, that have been identified, but not studied, from urban agriculture

have been ignored, relative to the recognition of its social benefits. There may be environmental benefits unrecognized and under exploited. This may be the most dynamic aspect of urban agriculture.

It seems likely that neither sustainable agriculture nor sustainable human settlements are feasible without urban agriculture. This may be so in part because:

- millions of the world's farmers are urban farmers,
- agriculture may be the most powerful tool we have to close open, urban, nutrient, carbon and pollution loops.

As an urban economic activity agriculture has attractive attributes. It creates jobs at low capital investment. It is a 'basic' industry that stimulates growth in forward and backward links. It is a sub-sector in the agriculture and food industries which increases their efficiency and productivity. It is an industry that assists government in avoiding costs in land and waste management. And altogether increases the size of the urban economic pie.

The relationship of urban agriculture and low-income groups is particularly positive. It advances well-being for low-income families as they have better access to food and income. It contributes to health through nutrition and improved environment, resulting in more days at school and more days at work per year. It is an industry of choice for women, particularly as micro-enterprise. It is a good hedge against inflation. And it is a survival activity in times of civil and natural disaster.

Urban managers by-and-large have not been doing a good job of either regulating or supporting urban agriculture. Without the support of local government the industry cannot achieve its potential. Much needs to be studied and improved in how municipal and metropolitan governments manage this industry for environmental, economic and social benefits.

A shift is underway in the 150-year trend to separate cities and their source of nutrition. Habitat II and the Food [security] Summit provide an opening to allow supra-national policy and program to bring optimization strategies to focus the trend of urban agriculture towards the greatest benefit to all, and particularly the biosphere.

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Urban Agriculture Notes

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Urban Agriculture And Livestock In The City Of Mexico: An Option For A Sustainable Future

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Mexico City is one of the largest urban centres in the world with an estimated population of 22 million living within a surface area of 100,000 hectares. Although the urban development of the city has been carried out following a western model, the long-standing relationship between the city's inhabitants and a cultural tradition of agricultural and animal production based on the use of the new urban spaces and the city's organic wastes has resulted in a technology nearing the concept of sustainability and which introduces the possibility for future self-sufficiency within the large urban concentrations of the capitals of the world.

Research carried out by the Autonomous Metropolitan University at Iztapalapa (UAM-I) has put forward the idea of the existence of three types of space in which agriculture and animal production occur within the city of Mexico. These have been defined as: urban, sub-urban and peri-urban. These spaces are differentiated by the origin of the population involved in agriculture (local or migrant) and the physical relationship between town and country. Characteristics of common interest to all three types of space include the use of recycled materials in construction and in the

management of livestock, and the integration of all the family - father, mother and children - in the various farming activities which in some cases are sufficient on which to live, while in other cases complement the family income or provides high quality foods.

Animal Production

The research that has been carried out in the east of Mexico City has revealed the presence of small scale stables which act as small dairy businesses, acquiring adult Holstein cows from the mechanised stables on the outskirts of the city, milking by hand and selling milk and cheeses to the local population. In this type of system a significant proportion of the fodder for the cows (over 70%) is made up of the fruit and vegetable waste generated by the large fruit and vegetable distribution centres of the city. The type of wastes used include maize husks, lettuce, cabbage and cauliflower as well as the foliage from other vegetables such as radish and broccoli. In addition, fruit and other horticultural products deemed unsuitable for human consumption are also made available to supplement animal diets. These include carrots, beetroot, maize and Castillean squash. Our studies have found that 100 tonnes of waste per day is used in complementing the feeding system of approximately 2500 cows, producing an estimated 37,500 litres of milk per day.

Other species of animals that have found a new habitat within Mexico City include pigs and poultry. These are kept within the backyards of family homes. Our research has reported that producers keep an average of 3 pigs and 26 birds per household, but there are some individuals who manage up to 60 pigs, all kept within the family. The type of pigs and poultry reared include native breeds as well as specialised breeds originating from mechanised farming systems - Yorkshire and Hampshire breeds in the case of pigs, Rhode Island and Leghorn in that of poultry. Their nutrition is based on the use of food wastes available from the city including kitchen wastes, stale bread and tortilla, left-over tortilla dough, chicken guts, and fruit and vegetable wastes from the markets, amounting to 4000 tonnes per day.

Some of the pigs and birds are slaughtered in the house in order to prepare various dishes for special family events, but the majority are bought by the city's abatoires, slaughtered and sold to the meat retail trade. Secondary reasons for keeping backyard animals have been found to include, as a source of money in cases of unpredictable economic emergencies, egg production to meet local demand (for use in 'magic', limpias etc.) and in some cases for sport (cock fights).

Arable Production

In the zone south of Mexico City urban growth has been less dramatic which has allowed these spaces to retain their rural character, and consequently act as 'reservoirs' for local tourism. The systems of food production have maintained a form

conventional to the rural sector of the rest of the country - with arable production representing the dominant activity, while livestock and forestry are secondary activities with long-standing relationships with arable production.

According to the results obtained from UAM-I's various strands of research, the region incorporates two models of production dating from the prehispanic era and one other brought by the Spanish colonisers - all influenced by the topography of the city. The first of these can be found in the lowland areas and includes the chinampas ('floating gardens') zone where horticultural production - ornamental plants, flowers, maize, beans, squash etc. - predominates, along with other production processes associated with the culture of the area (such as backyard livestock, kitchen gardens and cattle rearing for milk and meat). The second of the aforementioned models is situated in the upland zone dominated by terraces, where temporal crops adapted to the area are produced - maize, oats, cut fodder and of particular interest, nopal.

This same region is also important for its forestry products - firewood, wild mushrooms, resins and timber for the construction of houses and furniture. Other farming systems important in the terraced model of production include natural pastures and cultivated meadows used in the rearing of sheep, for which there is a regional demand (being used in the preparation of barbacoa or steam-cooked meat, stimulated by the increasing importance of tourism in the city). Also included within the upland model are family kitchen gardens and backyard livestock which constitute a form of production associated with the local culture in which the population live alongside the animals that are used for agricultural activities on the terraces. A third, transitional zone is made up of the small valleys that bisect the mountains, in which irrigated agriculture for the production of quality fodder (alfalfa) predominates, along with that of maize.

An analysis of the studied animal and agricultural production systems reveals a close relationship between the different spaces and systems, with the waste products of one system providing a source of energy and nitrogen for another, establishing a good basis for the development of a sustainable alternative for large cities. This interaction is well exemplified by the small-scale milk production of the urban dairies. The organic wastes produced from these stables potentially represent a source of contamination, but are used instead in the production of nopal in the terraced zone in the south of the city - a crop of good productivity with minimal water requirements and able to grow in eroded and/or poor quality soils, and with natural limitations for mechanisation. The excreta from the dairy stables represent a 'connecting agent' which has allowed the producers from both systems to maintain production despite the problems presented by their agricultural medium.

The nopal (Opuntia ficus indica) of Milpa Alta is a plant native to Mexico which was first domesticated by the early populations of Mexico, selected for its production of edible leaves. In fact it is possible to consider this perennial crop to be the most important in the zone, with an area of approximately 6000 hectares and a production in excess of 200,000 tonnes (per year), 75% of which is consumed within Mexico City,and the rest being used in the neighbouring states with a small quantity being

exported to the United States and Japan. In all the nopal plantations the use of cattle manure as a source of organic matter and fertiliser is intensive, with a reported use of an average of 600 tonnes of fresh excreta per hectare per year - allowing a weekly harvest of leaves for sale. The producers have indicated that collateral effects of the manure include its properties as a source of water and heat during the dry and cold seasons.

A common issue which has confronted these new forms of agricultural production within the environment of Mexico City is that of the divergence between what the producers do and how the authorities feel agriculture should develop. The differences between the two has created a dichotomy, apparently without solution but rather has brought about a loss in natural materials and resources and incomes which could have been used for the common welfare of everyone.

Interviews with the local authorities carried out by the research team of UAM-I have identified the existence of a series of problems associated with the stables and backyards caused by complaints form neighbouring residents. These complaints relate to the presence of flies and rats which accompany the handling of animal excreta and feed stuffs, the blocking of drains, the excessive use of water and the absence of hygiene employed in the management of the animals and their products (principally milk). If there is any truth to these claims, the evidence suggests that there exist factors which both favour and inhibit their presence, such as the amount of time the neighbourhood has shared the urban space with the animals, and also the external pressures of construction companies looking for land suitable for housing developments.

One possibility that has been put forward on several occasions by Mexico City's authorities to solve the problem of the stables and neighbourhood relations, has been the suggestion of removing the stables from their urban context and relocating them in areas peripheral to the metropolis. Despite heavy investments by Mexico City's government the results to date have been negative, as is demonstrated by the discouragement of dairy activities, sale of animals and in the final instance, the irretrievable loss of an agricultural system. An analysis of the effects of aforementioned suggestion of relocating dairy production has overwhelmingly indicated the creation of new problems for the producers, allied with difficulties in obtaining feed to support production, increasing costs of transporting feed, serious difficulties linked to the market for milk and its derivatives, for young animals and for waste which promote the role of intermediaries. All these factors lower significantly the profitability of these production systems.

According to this situation it is clear that whatever the current government proposal, it must take into account the fact that these urban animal production systems were created under conditions particular to the metropolis, and consequently must be validated as forms of production which correspond to the concept of urban agriculture and be promoted by the authorities within this context. Not to approach the issue in this way is to generate further problems. For example, the suppression of the dairy stables would inevitably effect the producers of nopal and other crops in the south of

Mexico City, who faced with an absence of fresh manure would use instead inorganic fertilisers, thereby promoting pollution.

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Urban Agriculture in Drylands

Katherine Waser, Editor
Office of Arid Lands Studies
The University of Arizona

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The Spring/Summer 1998 issue of the *Arid Lands Newsletter* will focus on the theme of **ECOTOURISM IN DRYLANDS**. This issue, Number 43, will be published in April 1998.

Proposals for papers, comments, suggestions for possible authors, suggestions for resources (web, paper, CD-ROM etc.) to be included, etc. are welcome. Please email your suggestions to Katherine Waser, Editor, *Arid Lands Newsletter*.

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ARIDLANDS NEWSLETTER No. 42, Fall/Winter 1997
Urban Agriculture in Drylands

Urban trees in arid landscapes: Multipurpose urban forestry for local needs in developing countries

by Guido Kuchelmeister

"The street you live on in Tashkent is shaded by grape arbors.... The street is narrow: a connected row of brown-rose, two-storey houses....Across the street are larger gardens. Ideally, as at your home, the garden will be filled with fruit trees. You have mulberries, pomegranates, pears, apricots, apples, three kinds of cherry.... "

--Malcomson, Scott L., 1994. *Empire's Edge: Travels in South-Eastern Europe, Turkey and Central Asia.* Boston: Faber and Faber, Inc. pp. 180-181

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Introduction

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Urban development, environmental and social issues

The human habitat is rapidly urbanizing. By 2030, the urban population globally will be twice as large as the rural population (World Bank n.d.). Especially in developing countries, this rapid urbanization is exacerbating serious problems such as availability of food, fuel, water, employment, and shelter. The enormous toll in terms of losses to human health and quality of life, natural resources, and economic productivity, makes a compelling case for action (Bartone et al. 1994).

Too many cities are still designed strictly from an engineering perspective. Urban vegetation is often considered less important than the built structures, roads, and utility layers; yet, vegetation must be included in the planning process if healthy urban ecosystems are to be achieved. (Moll, Macie and Neville 95; Whiston Spurn 84).

Urban agriculture, urban greening and urban forestry

The term "urban forestry" requires some clarification. Many agriculture initiative include forestry in their overall definition of agriculture (UNDP 96; TMSGUA 96; Smit 96). In this context, urban forestry focuses on using trees to provide food, fodder, fuel and building materials.

Conversely, many urban foresters in developed countries use "urban

greening" and "urban forestry" interchangeably (Miller 97). In this context, urban forestry focuses on using trees for recreational and environmental benefits (Nilsson and Randrup 97).

This paper considers urban forestry as the planned, integrated and systematic approach to managing urban and peri-urban forests for their contribution to the environmental, psychological, sociological, and economic well-being of urban society. In even simpler terms, urban forestry is the management of urban vegetation to meet local needs (Kuchelmeister 96), while urban greening comprises all urban vegetation management.

Development assistance and urban forestry

Most current urban greening activities in development cooperation are initiated by the agricultural community, which does not yet sufficiently support urban forestry.

The major reason why foresters neglect urban forestry is that most contacts for development assistance in forestry are forest ministries, which are not responsible for development of urban and peri-urban areas. Furthermore, foresters tend to have less influence in cities than do landscape designers and gardeners. There is an urgent need to change this state of affairs.

In developing countries, urban forestry must initially focus on helping to fulfill immediate requirements for basic products. Recreation, although increasingly necessary, is less essential. Assistance in meeting basic needs can best be achieved by promotion of multiple use of urban forest resources (Kuchelmeister 96; Lanly 97).

The value of urban forests in arid lands

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Urban forests improve the quality of urban life in many ways. Tangible benefits include fuelwood, food, fodder, and building materials. Environmental and social benefits relate to public health, recreation, and well-being of the urban population. These benefits include reduction of air and noise pollution, climate improvement, and landscape enhancement. Green areas can also provide habitats for wildlife, erosion control, protection of watersheds for urban water supply and productive uses or safe disposal of urban wastes.

Tangible benefits

Trees can contribute significantly to the food requirements of the urban poor, both on a daily basis and in times of crisis. For example, foods like Baobab leaf, tamarind and processed Parkia seeds are very popular in large towns in the Sahel. Local tree species with medicinal uses are intensively exploited in and near towns (Sené 93). Trees are also an important source of animal fodder, particular during dry seasons. In some arid zones the

need for fodder is so great that even amenity trees are lopped (Carter 93).

Many urban residents in the developing world rely on biomass fuels for cooking and heating. Collection of fuelwood has caused extensive degradation around many arid and semi-arid urban settlements; properly managed urban forests can help alleviate this. However, with some notable exceptions such as Ethiopia, to date such plantations (usually of exotic species) have generally not improved fuelwood supply. This is either because higher-priced building materials were produced instead of fuel, or because poor people could not afford the fuelwood. To resolve this problem, "softer" methods incorporating agriculture, agroforestry and smallholder plantations could be adopted (Anderson and Fishwick 84; Cline-Cole 90; Kuchelmeister and Braatz 93).

Finally, urban trees provide shelter and building materials as well as raw materials for local processing industries and for many household tools and utensils.

Environmental benefits

Settlements in arid areas often suffer from sand and dust encroachment. The planting of shrubs and trees for shelterbelts, windbreaks, greenbelts and sand dune fixation has thus become common practice in arid areas (Sené 93; FAO 89; FAO 95), as demonstrated for example by the greenbelts of Ouagadougou (Kuchelmeister 91) and Nouakchott (Sené 93). Properly managed, such resources can provide significant quantities of fuel, building materials and other tree products without jeopardizing their primary function. In addition, hedges planted along contour lines can improve micro-climate and prevent soil erosion (Kuchelmeister 91).

Urban areas tend to be much warmer than the surrounding countryside. Trees keep their surroundings cooler in the summer by providing shade and evaporating water from their leaves. However, energy conservation through strategic tree planting is seldom deliberately included in urban housing projects in low-income settlements (Parker 97).

Urban trees play a significant role in control of global climate change by indirectly decreasing the consumption of fossil fuels for heating and cooling. Urban trees can mitigate pollution through reducing energy use, CO2 emissions, and ground-level ozone, as well as by purifying the air (McPherson and Rowntree 93; Nowak 95).

Trees planted along waterways can protect fragile land. Canal banks constitute a considerable area for timber and firewood production. Growing trees to utilize seepage water may be cheaper than lining canals with concrete and other material. Successful examples exist in Egypt, India and the People's Republic of China (Kuchelmeister 91).

Multifunctional parks and greenways (linear parks) both preserve natural areas and native vegetation and allow basic municipal services, such as solid waste and wastewater management, education, health care, and

recreation, to be extended to informal settlements. For instance, multifunctional parks may be used for stormwater catchment or sewage treatment by means of retention ponds or artificial wetlands (ICLEI n.d.). The forest park in Dakar aims to drain the Hann marshland and lowland and protect the aquifer (Sené 93).

Social and other benefits

Tree products, if sold, provide direct cash benefits; if used within the household they provide indirect cash benefits by freeing cash income for other uses. Trees themselves can improve existing savings/investments, secure tenure or increase property value. Tree products are also used for socially motivated exchanges, and parks and other green spaces provide educational opportunities for urban residents (Kuchelmeister 91).

Urban forestry programs can also help to strengthen urban community-building (Sullivan and Kuo 95; Salleh et al. 90). Green areas are important recreation sites in most cities. In general, lower income residents are more likely to frequent city parks in their leisure time than are wealthier citizens (Sorensen 96). Thus, loss of green space for recreation affects the urban poor most directly (Hardoy, Mitlin and Satterthwaite 92).

Attributing economic value

The monetary value of trees is not easy to estimate, and hardly any data are available for cities in developing countries. Prevailing tree appraisal methods (CTLA 92) are insufficient. Valuation techniques must be developed and tested to quantify and assign monetary value to multipurpose urban forest resources. Nevertheless, conventional economic appraisal of urban forests in industrialized countries shows that millions of dollars can be saved annually by reductions in engineering infrastructure costs for water supply, drainage, and cooling of buildings. Urban forests can be part of the urban infrastructure; in fact, whereas most infrastructure depreciates, trees may appreciate with age (Kuchelmeister 96).

Challenges facing urban forest development

Five major constraints impeding urban forestry programs in developing countries are:

1. **Local participation.** Preference and willingness, especially of the poor, to invest and manage urban green space has not been sufficiently approached, documented and communicated.
2. **Valuation:** Appropriate economic tools to place a monetary value on urban forests have not been formulated in most developing countries.
3. **Land and tree tenure:** Insecure or unclear ownership and/or rights to the use of urban forests can impede any involvement of the poor. Insufficient or inflexible tree ordinances tend to discourage participation of low-income citizens in urban forestry.

4. **Institutional capabilities:** Lack of coordination, long term planning difficulties, and uncertain sustained budget allocations plague many cities and affect urban forestry development.
5. **Technical constraints:** New technologies are needed for matching trees to urban sites. The overdependence on a few varieties/clones for urban tree planting causes great economic and ecological risks.

Some basic requirements for urban forestry programs

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Participation and planning: Many urban forestry projects have failed because they were designed and executed in isolation from overall urban planning. In addition, as history has shown, social conflicts regarding urban forests have often been frequent and intense (Kronijnendijk 97). For urban forestry to be successful, a variety of key players--and above all local residents--must be involved in policy-making, planning and management, and benefit distribution.

Technology: New innovations generated in urban forestry in industrialized countries are not always appropriate for low-income settlements. Wherever locally developed practices exist, they should be reinforced and improved. The use of attractive multi-purpose tree species, natural forest management, multi-purpose small-scale peri-urban plantations, and agroforestry practices like multistory gardens have to be explored and demonstrated more intensively (Kuchelmeister 93).

Currently only a very limited number of species, mostly ornamental, are promoted. For ecological and economic reasons the number of multipurpose species used must be increased (Lists of multipurpose urban trees and shrubs for arid zones can be found in Kuchelmeister 91; Maydell 86; Sené 93). In addition, given the scarcity of water in arid climates, various water-sparing landscape scenarios need to be developed. One such practice is xeriscaping, which replaces lawns and other high-water-use species by drought-tolerant trees and shrubs (Akbari et al. 92).

Information and research: Multipurpose urban forestry research in arid zones is in its infancy, especially in developing countries. Existing information is widely scattered and not easily accessible. There is little published information about the relationship of urban dwellers (particularly the poor) in developing countries to urban green areas; on how they value, use or would like to use these areas; and how urban forests affect health and well-being. Foresters are therefore urged to take part in the current research and development efforts by agronomists to increase urban agricultural production. They can also play a key role in developing multiple resource inventories.

Training and extension: There are very few training and extension programs for arid urban forestry focusing on low-income citizens. In most

cases a new kind of urban green manager has to be trained--one who can deal with the multiple dimension of urban forests, handle the different stakeholders' interests, and strike a balance among competing needs.

Networking and initiatives: To date, few global networking initiatives have focused on planning and management of urban forests in low-income settlements. The TREE CITY Initiative (*ed note: see URL at end of article*) is one such effort. USAID, FAO (Braatz 93) and the Interamerican Development Bank have recently started their own initiatives. The Global Facility for Urban Agriculture and the International Urban Agriculture Network (TUAN) are further initiatives which could be used to promote urban forestry.

Financing: As a rule, municipal budgets are insufficient to fund adequate urban greening programs. Innovative funding must rely heavily on local volunteers, not only to raise funds, but also to provide program leadership and physical labor. Funding strategies might attempt a mix of public funding; cost avoidance, reduction and recovery; and use of trusts and private funds (Sorensen 96). Financial development assistance for urban forestry projects including networking, documentation, development and refining urban forestry concepts, and evaluative research, should also be increased.

Conclusions

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Urban trees should be viewed as an integral part of the urban infrastructure and an asset in arid settlements. The quality of life, especially of vulnerable groups in arid zones, can be significantly improved by better integrating multipurpose urban trees and shrubs in urban design and urban development initiatives. However, urban forestry has not yet received the attention it deserves in development cooperation. To develop and sustain urban forests in developing countries, urban forestry must initially focus on fulfilling immediate requirements for basic products. This can be best achieved by the types of multiple resource use advocated in this article.

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Author information

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Additional web resources

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FAO Programme on Urban and Peri-Urban Forestry
(http://www.fao.org/forestry/for/forc/urbfor/urbfor-e.stm)
FAO launched its urban and peri-urban forestry work in 1993. Currently, there's just a brief description of the program and some contact information at this web site address. However, an annotated Urban Forestry Bibliography (cited in the references list of this article) is due to be uploaded soon. Given FAO's focus on food production, this is a site to keep track of as it develops.

Editor's note: while I found other web sites concerning "urban forestry," they almost invariably turned out to be focused on "urban greening" (in developed countries) rather than urban agriculture. Therefore, I chose not to list these sites here. For those interested in finding out more about urban greening, such sites can easily be found with any major web search engine using the term "urban forestry" or "urban greening."

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Introduction

To some people, urban farming might sound like a contradiction in terms. Farming is often seen as a rural occupation, and cities as consumers of rural foodstuffs. But the truth can be rather different. Many cities simply could not feed themselves without the produce of their backyards, roadside verges, riverbanks, parks and allotments. Hectare for hectare, urban farming is often among the most efficient and intensive forms of agriculture anywhere. And it can be a vital source of vegetables for many poor and even middle-income households.

"The stereotype is that when people move to urban areas they abandon agriculture. In fact our findings show that the majority carry on in some form," says Adrienne Martin, a social scientist from the NRI. And yet urban agriculture often exists in a legal no-man's land. It often takes place on illegally occupied land, and may even be formally banned. It gets by with little or no financial help, and farmers are at constant risk of being evicted even as their crops grow.

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Setting the Scene

The land in and around Harare, the capital of Zimbabwe, has a cool, wet climate and there are large green spaces. This makes it fertile ground for urban farmers. River floods in the long wet season deter developers from low-lying land, but provide free irrigation for farmers, often allowing two harvests.

Tomatoes, green leafy vegetables such as rugare, and maize are the major crops. "We grow to eat and to sell at market," says Angeline Mbabvu in Dombashava, some 20 kilometres from the centre of Harare. Mrs Mokokota, secretary of a school in the suburb of Epworth -- one of the poorest but fastest growing urban areas in Harare -- says she grows vegetables "to make our family happy", and to bring in cash to buy meat. It is a vital part of their

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Taking action

Adrienne Martin and Nicolienne Oudwater from the NRI have investigated how poor urban farmers - who are mostly women - can help to feed their families and earn cash on urban plots in three areas around Harare. They have found that in some parts of the city more than two-thirds of households carry out some farming, either around their homes or on public land such as roadside verges. Aerial surveys suggest that the area of the city under cultivation has doubled in the past decade.

Adrienne says many urban households farm to diversify their income and reduce their vulnerability to unemployment, droughts and other calamities. In Epworth, family members take unskilled jobs with wages when they can, while others sell craftwork or run shops and stalls, and still others farm maize, sweet potatoes and cabbages in their back yards and on boggy common land.

The official view remains that urban farming is bad for the environment and dangerous to health because standing water and damp vegetation attract mosquitoes and rodents. Government land policies prefer to stress the rights of the poor to return to white-owned rural farming areas through land reforms. But the team found that in the fractured state of land tenure in the countryside, urban agriculture can be a vital means of survival.

Porta Farm, a community of some 4000 people on the city's western outskirts, is officially a temporary holding camp, inhabited by many people moved during the clearance of squatter settlements in central Harare before the Commonwealth Heads of Government meeting in 1991. "We were supposed to stay for three months," says Mrs Chikonhi. But a decade on they still await their promised housing plots, subsisting meanwhile on growing crops and fishing near the camps. Alois Guta was moved the same year from a squatter settlement near Harare airport, and took up farm work to get money to send children to school.

But there is another aspect, too, says Adrienne: enjoyment. Many rural families are drawn to cities by the need to find work. But they retain their rural links, and urban farming "makes them feel complete as a human being". Town planners, she says, must end their hostility to urban farming. "The process of planning and decision-making about urban space has to take into account peoples' needs for areas in which they can grow crops."

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The cast

"The stereotype is that when people move to urban areas they abandon agriculture. In fact our findings show that the majority carry on in some form," - Adrienne Martin, social scientist at the Natural Resources Institute.

- Angeline Mbabvu of Dombashava
- Mrs Chikonhi of Porta Farm
- Alois Guta, of Porta Farm
- Mrs Mokokota of Epworth.

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Global Relevance

Urban farming is a worldwide phenomenon. According to the UN development Programme, one in three of the world's urban residents grows some food, and urban areas provide around 15% of global food production. In the cities of England, thousands of people grow food on allotments set aside by local authorities. In Bangkok, 60% of the land is devoted to farming. In Moscow, two-thirds of families grow some food.

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Thinking points

- Urban farming is an integral, but often unacknowledged, part of the economic activity of most of the world's urban areas.
- Planners and politicians must plan for successful farming in and around urban areas, and ensure that the poor and vulnerable in the community can use it to improve their livelihoods.

Research on peri-urban livelihood activities in Harare was funded by the European Union

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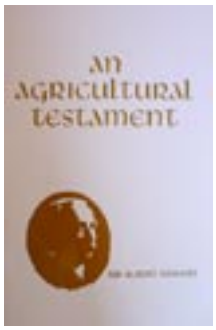

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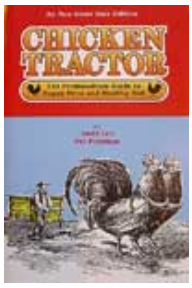

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Urban Agriculture Notes

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Roofwater Fish Farm Ideal For Learning

An Agrovision Publishing Report
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Scientist Vivienne Hallman on periurban acres at Figtree Pocket, 10 kilometres from the Brisbane CBD, is proving that urban fringe farmers can grow native fish successfully on natural foods.

Most of the water can come from a home rooftop. Much of the fish food can be home-grown earthworms and insect larvae.

Vivienne's project has shown how Australian native fish could be reared in a small area on worm-farmed kitchen scraps - to give benefits to a vegetable or fruit tree garden.

But her story is also instructive from the point of view of starting up a fish farm in a backyard or an urban fringe (periurban) farm - or even on a larger farm, where diversification is possible.

I believe the fish farm of 25,000 litres of tank space is the ideal next learning step for an intending fish farmer who has learned enough from an indoor fish tank and wishes to become more serious.

It is probably the best way to ease into a larger fish farm investment, while reading avidly and even studying aquaculture by correspondence.

Vivienne started her fish production unit in 1991 as part of a fish farming research

project associated with Kevin Warburton of the University of Queensland.

The project was to see how dairy farm wastes could be used to grow natural fish foods - so that purchasing of expensive, bought-in fish foods could be avoided.

Features of her fringe farm unit now are:

- It has harvesting of rooftop water from her home - into an above-ground pool that holds at least 50,000 litres. About 25mm of rain yields 10,000 or so litres at a time. Minimal town water supplement is needed (and could perhaps be replaced by further water harvesting.
- It has five above-ground tanks (former above-ground pools) each holding about 4,000 litres and up to 50 fish.
- Silver perch, a native warm-water species, is grown from fingerlings to a plate size of 350 to 400 grams.
- Fish are fed earthworms, insect larvae and pelleted food. They also have natural food from pond life which develops in the five tanks.
- As water is fouled by fish excreta and decomposing food waste, it is used to irrigate vegetables and fruit trees, which also gain from additional fertiliser from worm castings.
- Water flow is mostly by gravity, the exception being the pumping of orchard irrigation water using a small petrol-motor powering a pump.

How many fish meals can Vivienne's small fish farm produce in a year ?

The answer depends on how much feed can be produced and the water temperature.

"One crop a year of silver perch is possible with unheated water," she said. Up to 50 fish a year can be raised in a 4,000-litre, unheated tank, to 350 to 400 gram size.

"This means each of my five tanks is capable of raising 17 to 20 kg of silver perch under the non-stressful growing conditions I favour," Vivienne said.

"It's a total potential output of 80 to 100 kgs - more than enough for my family's needs, plus the potential of a small saleable surplus."

That potential surplus could also be improved if simple solar heaters could warm the water during Brisbane's mild winters. Two crops of fish a year might then be possible, providing the food supply was improved also.

However, Vivienne has never produced a surplus because her work has focused on harvesting scientific information rather than fish.

Her main interest, after all, is being a consultant with a rare depth of understanding of both scientific and the practical systems.

Besides earning a masters degree of engineering science in environmental engineering from Griffith University in 1997, she obtained a bachelor of science degree from Sydney University in 1964.

Balancing these are her Permaculture consultant qualifications and worm farming experience.

Vivienne set up and managed the innovative worm farm at International House, at the University of Queensland, where the food scraps from meals for around 100 students were converted into nutrients for a Permaculture garden.

This urban farming opportunity will be the subject of a story in the next issue - in both small and large-scale applications to food waste management.

But Vivienne is also well-focused on mainstream agriculture. Her environmental engineering degree thesis, was on the suitability of earthworms for recycling solid and liquid waste from the dairy industry.

That too, could involve fish farming - and the type of small scale learning experience that is relatively easy to set up on an existing dairy farm with reasonable rainfall.

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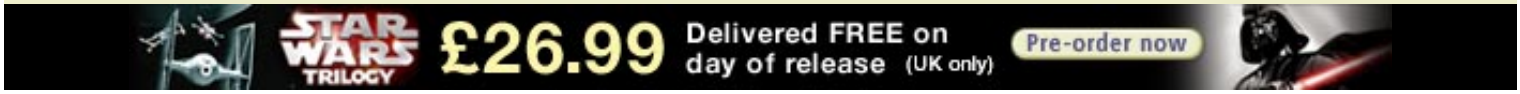

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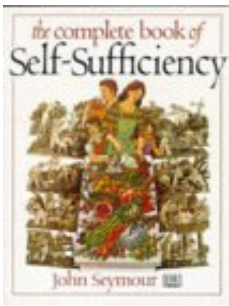

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Reviews

Synopsis
First published in 1976, this book calls readers to respect the land, reap the harvest, waste nothing, stay healthy and live well.

Spotlight Reviews
Write an online review and share your thoughts with other shoppers!

40 of 41 people found the following review helpful:

★★★★★ LIfe Changing, June 13, 2002
Reviewer: ftully3 from Sandy, UT - USA

I have long considered myself very capable of self-sufficiency and survival - until I read this incredible book. Mr. Seymour's book shared hands-on information that would otherwise take years of trial and error or a fantastic personal relationship with a local farmer to acquire. His precise descriptions of necessary homesteading tasks are nearly extinct from today's society. His legacy is that he has preserved information that can help mankind endure nearly any crisis, no matter where in the world they are. This book can enable the common 9 - 5 working stiff to become truly independent and self-reliant. Now, anyone with will can make a conscious decision to be as completely independent as they choose to be.
Until I read this book I had vowed to never have a cow or a pig on my holding, due to their being prone to disease as well as their smell and damage to the land. His first-hand knowledge has completely changed my mind. After reading this book, I will never again consider having a homestead without both. His calculations on labor from animals vs. machines and formulas for feed required for stock are extremely useful. Regardless of whether one desires to be 100% self-sufficient with 5 acres, make a good living with 50 acres, or set up a small 1 acre homestead and live extremely healthily and simply - this book is a must read. By far the most comprehensive and useful book on self-sufficiency I have ever come across. It is the how-to book for all ages. It's ability to honestly reveal a completely exhausting 365 day a year work schedule may also weed out

many dreamers who will be left fatigued by the end of the book. I can't wait to get started.

Was this review helpful to you? YES NO

50 of 51 people found the following review helpful:

★★★★★ Easier than "Teach yourself" books, 100 times more fun!, March 21, 2000

Reviewer: (a_massari@cableinet.co.uk) from Bristol, England

John Seymour has made self-sufficiency feasible. This book gives you al the information you need and more! From planning your 1 or 5 acre plot to crop rotation, from making beer, bread and rollmops to building a furnace! Essential accessory to self-sufficiency, whether you need to remove a tree stump, butcher livestock, harness a ploughhorse, plan your dairy, brew beer, dress stone or even distilling! The drawings are stunning, exquisitely drawn and incredibly clear. It is also a sobering caveat for those planning to dream the dream... Read John Seymour and at least you'll KNOW what you're letting yourselves in for! :¬))

Was this review helpful to you? YES NO

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16 of 17 people found the following review helpful:

★★★★★ Very Useful!, July 3, 2002

Reviewer: A reader from Romania

Like some of the other reviewers I found this book so full of practical information that it made me want to go out and do it - which is what I am in fact starting to do.
The writing is not theoretical - you get the feeling that Mr Seymour has actually done everything and knows it works. Instructions are very clear and well supported with illustrations. Whether you are out to totally change your lifestyle and do a 'Goodlife' or just want to get a little more control over your own life through making your own cheese (A real Stilton can be made!), it is an essential introduction.

Was this review helpful to you? YES NO

8 of 12 people found the following review helpful:

★★★★★ An excellent book, February 12, 2002

Reviewer: A reader from the East Anglian Fens, uk

I have read this book with great enthusiasm, the writing style is

informal and packed with beautiful details, it is a must for those that really want to have a go or for those that just want to dream. An excellent book.

Was this review helpful to you? YES NO

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Urban Agriculture Notes

Published by City Farmer, Canada's Office of Urban Agriculture

Summary of CityHarvest: The feasibility of growing more food in London

City Harvest: The feasibility of growing more food in London
By Tara Garnett, July 1999. £30.00
Purchase from: **Sustain**
This 160 page report provides a thorough overview of the feasibility of food growing in London, a comprehensive list of all the necessary contacts required to develop a growing project, case studies, and how to take action yourself at an individual or community level.
This report is also a follow up to the 1996 **Growing Food in Cities** report.

London: an introduction

Summary

London is a large, complex and constantly changing city which is difficult to describe, let alone define. It contains extremes of wealth and health and, as well having areas of great beauty, suffers from environmental problems and contributes to environmental problems in the rest of the country and, indeed, the world. London's food system reflects these contradictory features, being at the centre of cultural renaissance in food yet at the same time experiencing food poverty. This manifests itself in a number of ways, including poor health, an underdeveloped food economy and, not least, a paucity of opportunities to grow food which would meet Londoners' varied needs.

Key facts

- Greater London covers around 157,800 hectares, and around 60% of it is green space
- As many as 12 million people live or work in London, and 10 million visit

every year
- Londoners eat 2,400,000 tonnes of food each year and produce 883,000 tonnes of organic waste

Urban agriculture

Summary

There is a surprisingly large amount of land in and around London where food could be, or is being grown. Some is farmed commercially, some is publicly owned (e.g. county farms, allotments, school gardens, parks), while parts are used by the voluntary sector (e.g. city farms, community gardens and community orchards). The proportion of land devoted to food growing has probably been declining, due to housing and other development pressures, funding shortages, and changes that are affecting farming as a whole. However, around half of London's households have gardens and the popularity of gardening is high and rising. Even among those keenest on ornamental gardening, there seems to be a growing interest in the edible, and a number of organisations exist to provide information, inspiration and encouragement, not only in the UK but globally.

Key facts

- Almost 10% of Greater London's area is farm land, there are around 30,000 active allotment holders and an estimated 1,000 beekeepers
- Some 650,000 people go to London's city farms and community gardens each year
- Taken together, private gardens in Greater London occupy an area roughly the size of the Isle of Wight and the garden industry is worth an estimated £2.7 billion annually

The environment

Summary

People who grow food in cities are not, inevitably, environmentally benign. Commercial, public and individual growers can use the same proportion of energy and agrimchemicals, produce the same narrow range of produce, and generate as much waste as their rural counterparts. Similarly, they can be just as good for the environment as some rural farmers, but with the added advantage of being closer m literally m to consumers. Biodiversity can be enhanced, as the tighter confines of urban areas encourage variety, both within and between species of plants (and animals). Shorter food transport distances can reduce packaging (and, therefore packaging waste) and the environmental damage associated with "food miles". Homemcomposting, and other composting options (including for sewage) can

diminish waste and provide the growing medium for more food.

Key facts

- An estimated _ of allotment holders use insecticides, but almost the same proportion compost their waste
- Composting kitchen waste could eliminate 40% of household rubbish, and research suggests that compost can reduce diseases in strawberries and peas
- Some 60% of Londoners said poor air quality and too much traffic topped their list of health concerns Ð locally grown food could reduce food transport, so improving air quality
-

Economic development

Summary

Unlike for other farming sectors, there is currently no financial or other Government support specifically for the urban food grower. There is little research data on the economic value of citymgrown food, although conventional measures of value seem unlikely to capture its multidimensional worth, even at current levels. And the potential is tremendous. Based on experience in London, the UK and internationally, the capital could farm livestock, a wide range of fruit, vegetables and herbs, honey, speciality mushrooms and fish. Processing and marketing, as well as production, remain underdeveloped, and farmers' markets, Women's Institute markets, Local Exchange Trading Schemes, box schemes and so on would all merit further research and development, by local authority purchasers or commercial companies. The same is true of composting and ancillary industries.

Key facts

- Several species of fish have returned to the Thames as its water quality improves
- The value of London's composted waste has been estimated at £6.1 million, and could generate 350 full time equivalent jobs
- Thames Water sells treated sewage and, in the process, generates enough methane to supply power to 6,000 homes

Health

Summary

There is a great deal of anecdotal evidence that growing food in cities can be good for your dietary, physical and mental health. It is difficult, but not impossible, to measure these health benefits more rigorously though it has not been done, to our knowledge, in this country. "Hard" and "soft" data show that growers tend to eat more fruit and vegetables, be more active, and to report a better quality of life than nonmgrowers. This holistic approach lends itself well to Government's policy of improving public health, and there is much scope m currently undermexploited m to incorporate food growing into Health Action Zones, Health Improvement Programmes and Healthy Living Centres, as well as into settings such as healthy schools and healthy workplaces.

Key facts

- We should eat at least five portions of fruit and vegetables every day to improve our health. Average UK consumption is around three portions, but food growers tend to eat more than average.
- Preliminary findings from research into conservation work as a "green gym" show that participants' strength improves
- People with mental health problems regularly report that growing food and other plants significantly improves their quality of life

Community development

Summary

For some, food growing is a way of coping Ð rather than communing Ð with local people: a chance to get away from it all in a peaceful, productive haven. For others, growing food with other people is a way of stimulating friendships with people from a wide range of different backgrounds. Food growing schemes can be a focus for genuine partnerships, helping to rebuild local structures, both physical and institutional. Such projects can also generate a sense of ownership and responsibility, and provide a way for people who have been isolated or disaffected m unemployed people, young people, senior citizens Ð to reconnect with and make a valued contribution to their neighbourhood. Supporting urban agriculture can also be a way for local employers to show their commitment to the area.

Key facts

- Community food growing can provide a focus for a wide range of icembreaking social and celebratory events
- Local authorities are already investing in food growing initiatives as part of their urban regeneration programmes

- Some food projects are beginning to integrate the food chain, either "forwards" (by exploring outlets for produce they have grown) or "backwards" (thinking about growing their own food to cook, or sell through a comop)

Education and training

Summary

The process of growing food can provide almost limitless opportunities for learning, as many educational institutions have already discovered. It can be adapted to all ages and abilities, and can be as structured or as informal as required, leading nowhere other than up the garden path, or to a range of qualifications and to employment. most activity is currently focused on younger children and on those with less academic ability, as there is often more flexibility and less examination pressure. Urban agriculture's potential for contributing to curriculum development and the education of older children and adults could be further developed. Similarly, food growing could provide far more opportunities for employmentm related training than many people realise.

Key facts

- An inspection of a primary school made a point of praising their food growing activities and urged them to maintain the initiative
- Some 700 schools are members of Learning Through Landscapes, a charity that greens school grounds for educational and community benefit in London
- The environmental "industry" is one of the world's fastest growing sectors, so training in sustainable technologies for growing, processing and distributing food will be essential if the UK is to take its place in that market

Sustainable land use

Summary

Food can be grown without "land" as we traditionally conceive it, for example on roofmtops, in window boxes and in soil-less systems. However, land remains central to the future of urban agriculture. The most space and, therefore, potential, probably lies on the urban fringe, though complex ownership structures and planning policies inhibit its development for this purpose. Yet built up areas can also yield useful growing spaces, such as parks, housing estates, temporarily vacant land and, of course, the type of food growing land most people think of Ð and which remains invaluable Ð allotments. many people worry that urban land will be too contaminated to produce food safely, and the problems Ð particularly the cost of soil testing and remediation m should not be underestimated. But there are a number of lowmcost ways to solve (or avoid) the problem, and much London land is just as suitable for

food growing as anywhere else.

Key facts

- A number of Planning Policy Guidance notes could be used to protect and enhance land for growing food in London
- Around 14% of Londoners already grow some food in their own gardens, and free or lowmcost advice and equipment could increase this substantially
- Raised beds, using barrier hedges and mulches, careful selection of crops, and thorough washing of produce can avoid most contamination risks, which are lower than most people think in many areas
-

How much could London produce?

It is probably impossible to calculate accurately how much food London could produce, given the multitude of complicating factors to consider. It depends for instance, on what policies are in place to support urban food growing and on practical issues such as soil contamination. The figures below are simply estimates of the proportion of various land types which could be made available given strong political will. The potential productivity is based on an estimated average yield per hectare supplied by those active in the community gardening/allotments movement.

The calculation is based only on fruit and vegetable production. Setting aside land for other uses, such as beekeeping or animal rearing would generate a different result. It should also be noted that the calculation does not take into account the potential yields from window boxes, rooftops, street fruit trees and many other areas where food could be grown.

It is hoped that, while very approximate, the figure might provide a starting point for discussion and further, more detailed research. Using a productivity level of 10.7 tonnes/ha drawn from research into allotment yields, London could produce around 232,000 tonnes of fruit and vegetables. Taking the World Health Organisation's recommendation that we should eat around 0.5kg of fruit and vegetables a day (five portions), the amount potentially available would supply Londoners with 18% of their daily intake - roughly one of the recommended five portions a day.

Recommendations

This section summarises the recommendations made throughout the report, grouped together under the following headings:

- Local statutory agencies
- The Greater London Authority
- National Government

- Business
- Voluntary organisations

Recommendations that encourage two or more departments or agencies to work together on particular policies are repeated under each department or agency heading.

Local statutory agencies
Environmental agencies

in outer boroughs should incorporate and promote sustainable agriculture within the context of their countryside management strategies

- should promote food growing within local Agenda 21 fora
- should work with local allotment associations to consider allocating parts of allotment sites to organic gardeners, and to promoting sites with high vacancy rates as organic only sites
- should promote allotments in appropriate ways to different interest groups including unemployed and low waged people, the elderly, families and people of ethnic minority origin
- should promote self management of allotment sites and assist with examples of good practice
- should promote community and home composting and develop and/or support door to door organic waste collection schemes
- should establish onmsite composting schemes in parks and use boroughmcomposted waste in their landscaping activities instead of peat and other bought in soil improvers
- should aim to have 70% of households with gardens composting their waste by 2005. measures to achieve this could include distributing free or subsidised composting units, advice and workshops, trained volunteers, composting hot lines and making available chippers to handle woody materials
- should develop composting schemes for market and other commercial organic waste
- should promote biodiversity by planting heritage varieties of fruit trees and edible plants in parks and streets

Economic development agencies

in outer London boroughs

- should encourage farming tenants to convert to organic production by offering them rent rebates during the conversion period
- should develop the potential of local authority owned county farms as examples of best practice in sustainable agriculture
- should examine ways of stimulating and supporting local food production, processing, marketing and associated industries, including local food growing

schemes, urban fringe farms, box schemes, farmers' markets, food growing equipment and seed companies, composting activities and so on.
Regeneration partnerships and community development

- should incorporate local food growing activities as a means of linking jobs, environmental improvement and health promotion into delivery plans for New Deal for Communities, the Single Regeneration Budget and other regeneration initiatives, provided that local communities support and participate in managing such projects
- should provide continuity of support, staff and funding for schemes

Purchasing departments

- should seek to purchase food as locally as possible, within a best value framework >

Health promotion agencies and NHS Trusts

- should develop and support local food growing projects within the context of Health Action Zones, Health Improvement Programmes and other health promotion strategies
- should incorporate food growing into other initiatives including food coops, community cafŽs and exercisemonmprescription schemes and should consider making healthmauthority owned land available for the purpose
- should evaluate the mental and physical health benefits of food growing schemes and build upon their experiences
- should work with area based regeneration programmes to develop food growing projects as a means of linking health, jobs and environmental benefits

Education, training and employment agencies and Education Business Partnerships

- in outer London boroughs should maintain and develop Council owned farms as centres for training in sustainable agriculture and for educational visits.
- should fund informal and certified courses in sustainable food growing methods both onmsite, at adult education institutes, and offmsite at community run venues
- should link the Environmental Task Force and the Voluntary Sector Option elements of the New Deal for Employment to food growing schemes
- should promote food growing activities in first, primary, secondary and special schools and further and higher education colleges
- should work with health authorities and others to develop food growing activities as part of Healthy Schools Initiatives and in outmofmschool activities such as aftermschool clubs

- should acknowledge, promote and support the educational work of city farms, community gardens and other relevant voluntary groups
- should consider funding Ôgrower in the community' educational outreach worker posts, to stimulate and support education related food growing activity

Land use and planning departments

- should specify the value of urban food growing in their Unitary Development Plans (or equivalent, after 2000)
- should continue to maintain allotments even in areas where there is no present demand and examine alternative uses for vacant plots, including community gardens and orchards and wildlife areas
- should consider using surplus land surrounding municipal buildings and housing estates for food growing
- should promote food growing activities to self managed housing estates, including offering incentives for composting
- should consider using neglected and underused pockets of land in parks for food growing
- should provide guarantees of land tenure for established community food growing schemes

The Greater London Authority

- should promote and develop food growing activities as part of its duty to promote sustainable development, within the context of its Spatial Development Strategy, as part of its specific responsibilities to improve the environment, manage London's waste and transport systems and protect the capital's biodiversity and through its role in promoting Londoners' health
- the London Development Agency should promote urban food growing, processing and marketing as well as the development of composting initiatives and compost markets, within the context of its responsibilities to improve London's skills base and regional competitiveness.
- should, as a Best Value authority, seek to purchase food as locally as possible
- should advocate organic food production on allotment sites, in gardens and on other urban land
- should promote composting of domestic, municipal and sewage waste
- should promote local consumermproducer links such as farmers' markets and box schemes
- should promote sustainable food related intermediate labour market employment
- should work with Thames Water Utilities to explore composting options as an alternative to the incineration of sewage

- should aim to have 70% of households with gardens composting their waste by 2005.
- should support and guide local authorities in their work to promote urban food production by endorsing the recommendations to local authoritities, above
- should undertake research into the most appropriate crops to grow in urban areas and into low cost testing and remediation options for contaminated land
- should undertake research into the potential for developing food related industries, from production through to processing, marketing and waste management, and marketing this with appropriate labelling

National Government

Ministry of Agriculture Fisheries and Food (mAFF)

- should work with the DfEE and the DETR to develop both training and work schemes for unemployed people in food growing, including by providing access to land and start-up funds
- should commission research into the most appropriate crops to grow in urban areas; into low cost testing and remediation options for contaminated land and into the potential for developing sustainable small scale foodmrelated enterprises in production, processing, marketing and waste management
- should promote urban agriculture as an industry with a future, particularly to young people and people from ethnic minority backgrounds
- in partnership with the DTI and the DfEE, should support and promote small scale horticultural production, food processing, distribution and composting as part of a growing environmental industry
- should increase support for the horticultural industry, for small scale organic producers, and particularly for small scale organic horticultural producers

Department of the Environment, Transport and the Regions (DETR)

- Planning Policy Guidance should highlight the role of sustainable agriculture in enhancing the quality of Green Belt land and green urban areas and contributing to a sustainable transport policy
- should increase its composting targets for households with gardens from 40% to 70% by 2005
- should develop marketing standards for compost in partnership with mAFF and other relevant departments and non governmental agencies
- should research measures to treat sewage to standards suitable for food production
- should highlight food growing in future regeneration bidding guidances, including the Single Regeneration Budget and New Deal for Communities

Department of Trade and Industry (DTI)

- in partnership with mAFF and the DfEE, should support and promote small scale horticultural production, food processing, distribution and composting as

part of a policy to promote civic entrepreneurship, and as one element of a growing environmental industry.

- should promote the development of markets for compost, and support science and technology to support sustainable, cuttingmedge developments such lowminput hydroponics
- should shift the focus Food from Britain away from promoting British food for export to promoting local foods for local consumption

Department of Health (DH)

- should include the promotion of food growing in its strategies for healthy eating, physical activity and mental health
- should acknowledge and promote the beneficial link between sustainable food production and health

Home Office (HO)

- should encourage businesses to support employee involvement in community food growing projects
- should encourage people of all ages and backgrounds to take part in community food growing activities, as part of government's policy on volunteering
- should encourage work in food growing and related industries as community service options for offenders and people on probation

Department for Education and Employment (DfEE)

- as part of its curriculum review should acknowledge the contribution of food growing to: core curriculum teaching, personal social and health education, citizenship education and sustainable development
- should work with mAFF and the DETR to develop training and work schemes for unemployed people in food growing, including by providing access to land and startmup funding.
- in partnership with mAFF and the DTI, should support and promote small scale horticultural production, food processing, distribution and composting as part of a growing environmental industry.
- should promote food growing through Intermediate Labour markets

Department for Culture, media and Sport (DCmS)

- should commission research into why people take up food growing, and the cultural barriers to food growing and explore ways to overcome them as part of a strategy to integrate sustainable development into mainstream culture
- should promote allotment and community gardening as a form of active recreation for people of all ages, including the elderly
- should examine ways of promoting sustainable food production, processing, marketing and waste management within the context of its leisure and tourism strategy, including by highlighting the potential of initiatives such as "floating food markets" on the River Thames

The Treasury

- should allocate funding to develop and implement a strategy for promoting and supporting sustainable urban agriculture, for example, by offering tax incentives to water companies to pay farmers to farm organically, thereby reducing the costs of cleaning up agrimchemical contamination of water
- should consider introducing new taxes so that food prices more accurately reflect the environmental costs of their production and distribution, such as a distance tax on goods vehicles and an agrimchemicals tax

Business

- should promote employee involvement in community food growing activities as part of employer supported volunteering schemes
- should support local community foodmrelated projects with, among other things, funding, employee involvement, business advice and coverage and publicity in inmstore and inmhouse magazines
- should seek to develop ways of sourcing food more locally, including where possible, from urban producers and in particular should seek to encourage organic food production
- should develop links with local suppliers for staff canteens
- should consider ways of using green space, rooftops and other areas on, in and around business premises for food growing
- should promote and support food related educational activities through their involvement in Education Business Partnerships

Voluntary organisations

- already running food growing projects should seek to broaden the range of people engaged in food growing activities, including by developing appropriate publicity material, providing decent working conditions and by working closely with organisations who represent the communities in question
- should provide New Deal for Employment training placements, perhaps by aligning themselves with the Voluntary Sector Option, rather than the less popular Environmental Task Force Option
- should offer volunteers on food growing projects accredited training opportunities
- should develop links with local food growers and food growing organisations as a means of sharing information, strengthening the collective voice of food growers and developing better ways of working and growing
- that do not run food growing projects should consider ways of developing food growing as a means of achieving their organisational aims and objectives, or of incorporating, where appropriate, food growing into existing projects

Case Studies

Healing Gardens, Hillingdon
Jill Nicholas, Groundwork Thames Valley, Denham Court Drive, Denham, Uxbridge, Middlesex UB9 5PG tel:01895 832662

Grazebrook Treescape Project
Grazebrook Primary School, Lordship Road, London N16 tel: 0181 802 4051

The Natural Growth Project
Jenny Grut, Medical Foundation for the Care of Victims of Torture, 2 Langland Gardens, London NW3 6PY tel: 0171 435 4416

SHARE Horticulture Project
Jenny Shand, 64 Alternburg Gardens, London SW11 1JL tel: 0171 924 2949

Growing Communities
Julie Brown, The Firestation, 61 Lewisham Road, London N16 tel:0171 923 0412

Dartford Road Allotments
Graeme Laidlaw, 262 Princes Road, Dartford DA1 2PZ tel: 01322 409 184

Harington Scheme
John Turp, 55a Chomeley Park, Highgate N6 5EH tel:0181 341 3657

Cable Street Community Garden
Jane Sill, 101 Mathilda House, St Katherine's Way, London E1 9LF, tel: 0171 480 54 56

Surrey Docks City Farm
Daphne Ferrigan, James Taylor, Sarah Plescia or John Duignan, South Wharf, Rotherhithe Street, London SE16 1EY tel: 0171 231 1010

The Proper Job Community Comoperative
3 Fernliegh, New Street, Chagford, Devon TQ13 8BD tel: 01647 432616

Also see: International Planning Studies
Volume 4ÊÊNumber 3ÊÊOctober 1999
Food for Urban Spaces: The Development of Urban Food Production in England and Wales
Ruth Martin & Terry Marsden
page 389

Previous Study

Growing Food in Cities

A report to highlight and promote the benefits of urban agriculture in the UK

Written by Tara Garnett
June 1996 90 pages
Sustain
94 White Lion Street
London N1 9PF United Kingdom

This excellent report includes recommendations on policy integration; funding, support and promotion; land and water issues. On every other page the author has included a detailed case study of one of the UK's many urban agriculture programs for a total of 38. There is also a very useful 'Sources' chapter with paragraph descriptions of many UA support groups in the UK.

Contents include

Why grow food? Why in cities? Why now?
Community Development
- affirming identity and active citizenship
- combating discrimination
- preventing crime and rehabilitating offenders

Economic development
- training for jobs and for living
- creating local goods and services
- building an alternative economy

Education
- learning at school
- acquiring skills beyond school
- involving people with special needs

Environment
- increasing biodiversity

- tackling waste
- reducing transport

Health

- improving diets
- encouraging physical activity
- promoting mental health

Leisure

- stimulating volunteering
- generating sustainable tourism
- developing arts and crafts

Sustainable neighbourhoods

- reviving allotments
- diversifying parks
- regenerating housing developments

Issues affecting food growers in cities

- land
- water
- money and other inputs
- people, knowledge and skills

Excerpt from Growing Food in Cities (footnotes removed)

Cities and the Environment

At present. most cities are highly unsustainable, Although they only cover 2% of the earth's surface, cities consume 75% of its resources. The social, environmental and economic impact of a city, country or even an individual upon world resources has been described as its "footprint".

London's total footprint extends to about 125 times its surface area of 159,000 hectares, to nearly 20 million hectares. Home to only 12% of Britain's population, London nevertheless requires the equivalent of the entire productive land area of Britain to sustain itself.

Why is this so? Partly because we use more than we need and partly because we do not use what we do need efficiently. According to Ministry of Agriculture Fisheries and Food calculations, London requires 2,400,000 tonnes of food a year. which it imports from all over the world. Every day, London disposes of 6,600 tonnes of household waste of which only some 5% is recycled, even though much of this is compostable organic matter.

In effect, in their present form. cities are like parasites. feeding upon a global hinterland which is increasingly unable to sustain them. But the relationship is not intrinsically an exploitative one, Indeed, cities are potentially highly sustainable, and one aim of this report is to show that through urban food growing. the country can, in a sense, be brought to the town - to the advantage of both. In the words of the European Union Green Paper on the Urban Environment "Recreating the diverse multi-functional city of the citizen's Europe is . . a social and economic project for which 'quality of life' is not a luxury but essential."

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Revised November 24, 1999

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Canada's Office of Urban Agriculture
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Microlivestock: Little-Known Small Animals with a Promising Economic Future

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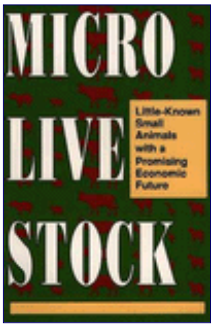

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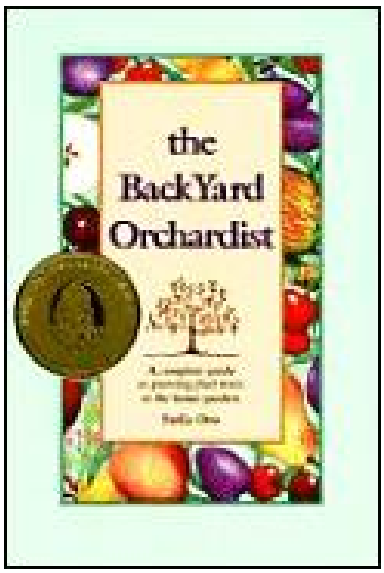
The backyard orchardist :a complete guide to growing fruit trees in the home garden
by by Stella Otto



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Fruits of Warm Climates

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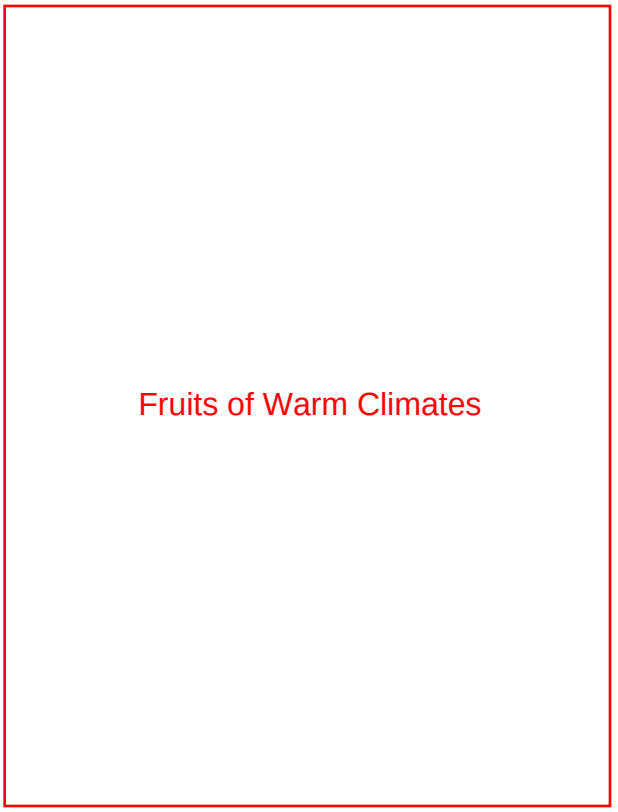

PALMEA
- Date
- Pejibaye

ARACEAE
- Ceriman

BROMELIACEAE
- Pineapple

MUSACEAE
- Banana

MORACEAE
- Fig
- Breadfruit
- Jackfruit and Related Species
- Amazon Tree-Grape

ANNONACEAE
- Cherimoya
- Sugar Apple
- Atemoya
- Soursop

- Custard Apple
- Ilama
- Soncoya
- Wild Custard Apple and Related Species
- Biriba

LAURACEAE

- Avocado and Related Species

ROSACEAE

- Loquat
- Capulin
- Mysore Raspberry
- Red Ceylon Peach

CHRYSOBALANACEAE

- Sansapote

LEGUMINOSAE

- Tamarind
- Carob

OXALIDACEAE

- Carambola
- Bilimbi

RUTACEAE

- Sour Orange
- Orange
- Mandarin Orange
- Tangor
- Pummelo
- Grapefruit
- Tangelo
- Orangelo
- Lemon
- Mexican Lime
- Tahiti Lime
- Sweet Lime
- Calamondin
- Mandarin Lime
- Citron
- Kumquat
- Sundry Hybrids and Rootstocks

Bael Fruit
Wood-Apple
White Sapote
Wampee

MELIACEAE

Santol
Langsat

MALPIGHIACEAE

Barbados Cherry
Nance

EUPHORBIACEAE

Bignay and Related Species
Emblic
Otaheite Gooseberry
Rambai and Related Species

ANACARDIACEAE

Mango and Related Species
Cashew Apple
Ambarella and Related Species
Purple Mombin
Yellow Mombin and Related Species

SAPINDACEAE

Lychee
Longan
Rambutan
Pulasan
Mamoncillo
Akee

RHAMNACEAE

Indian Jujube

TILIACEAE

Phalsa

ELAEOCARPACEAE

Jamaica Cherry

MALVACEAE

Roselle

BOMBACACEAE

Durian and Related Species
Chupa-Chupa

ACTINIDIACEAE

Kiwifruit and Related Species

GUTTIFERAE

Mangosteen
Mamey
Bakuri
Bakupari and Related Species

FLACOURTIACEAE

Ketembilla and Related Species
Kei Apple and Related Species

PASSIFLORACEAE

Passionfruit
Giant Granadilla
Sweet Granadilla
Water Lemon
Banana Passion Fruit
Sweet Calabash

CARICACEAE

Papaya and Related Species

CACTACEAE

Strawberry Pear and Related Species
Barbados Gooseberry

PUNICACEAE

Pomegranate

MYRTACEAE

Guave
Cattley Guava
Costa Rican Guava
Brazilian Guava and Related Species
Feijoa
Jaboticabas
Jambolan
Malay Apple
Java Apple
Water Apple
Rose Apple

Surinam Cherry
Rumberry and Related Species
Grumichama
Pitomba

SAPOTACEAE

Sapodilla
Sapote and Related Species
Canistel
Lucmo
Abiu
Star Apple

EBENACEAE

Japanese Persimmon
Black Sapote
Mabolo

APOCYNACEAE

Carissa
Karanda

SOLANACEAE

Naranjilla and Closely Related Species
Cocona
Cape Gooseberry
Mexican Husk Tomato
Tree Tomato

RUBIACEAE

Genipap

CUCURBITACEAE

Cassabanana

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Hong Kong to Cape Town Overland

Albert Howard

by Keith Addison, Journey to Forever

Sir Albert Howard was the founder of the organic farming movement. He worked for 25 years as an agricultural investigator in India, first as Agricultural Adviser to States in Central India and Rajputana, then as Director of the Institute of Plant Industry at Indore, where he developed the famed Indore composting process, which put the ancient art of composting on a firm scientific basis.

Howard was a brilliant development worker. Early in his career he abandoned the restrictions of conventional agricultural science with its increasing overspecialization -- "learning more and more about less and less" -- and set out to learn how to grow a healthy crop in typical conditions in the field, rather than the usual untypical conditions in laboratories and test-plots that represented nothing other than themselves.

He adopted the best teachers: Nature -- "the supreme farmer", India's peasants (whom he regarded as his prime "customers"), and the pests and weeds the scientists were committed to fighting with an ever-widening array of poisons, but which Howard called his "Professors of Agriculture". He saw pests in the context of Nature's use for them as censors of soil fertility levels and unsuitable crops growing in unsuitable conditions. He found that when the unsuitable conditions were corrected the pests departed. His crops were virtually immune to pest attack, and so was his livestock.

Journey to Forever founder-member Keith Addison says of Howard: "My first serious encounter with organics was as a journalist, in the context of Third World rural development work. I was investigating an ongoing famine in the sugar-growing areas of the Philippines and discovered a group there working on organics projects as a solution, and having some success.

"They realized they more or less had to educate me so I could understand what they were trying to do. It's a big subject and I was trying to get to the core of it. One of them went off and came back with some photocopies.

"'Read this,' he said. 'It's all here, it'll tell you everything you need to know.' I glanced at it: 20 pages, the introduction to a book called 'An Agricultural Testament' -- which

seemed to me a bit of an arrogant title. And I was a bit sceptical that just an introduction could encapsulate all these spreading complexities.

"But he was right, it did tell me everything I needed to know, it's a brilliant summary of the subject. Of course I wasn't satisfied with that and got hold of the book itself as soon as I could. And found that the title isn't arrogant, it fully lives up to its claim.

"I'll never finish reading this book -- I've read it through three times and referred to it scores of times, and each time I learn something new. Meanwhile I've read Howard's other books, and a lot of his papers and essays, and a great deal besides. I've talked to many other people, seen many other organics projects, farms and gardens in many different areas; I've used these techniques myself in a variety of settings, and it all confirms Howard's thesis.

"I still see it mostly in the Third World development context. To me organic farming is THE basic appropriate technology for rural areas. It's the best place to start -- get this right and so many of the other problems will simply vanish."

Resources

Introduction to "An Agricultural Testament" -- full text online at Journey to Forever.

The Manufacture of Humus from the Wastes of the Town and the Village -- "An Agricultural Testament", by Sir Albert Howard, 1943, Oxford University Press, Appendix C, full text online at Journey to Forever.

"An Agricultural Testament" by Sir Albert Howard, Oxford University Press, 1940.
This is the book that started the organic farming and gardening revolution, the result of Howard's 25 years of research at Indore in India. The essence of organics is brilliantly encapsulated in the Introduction, which begins: "The maintenance of the fertility of the soil is the first condition of any permanent system of agriculture." Read on! Full explanation of the Indore composting process and its application. Excellent on the relationship between soil, food and health. Full text online at the Journey to Forever **Small Farms Library**.

"**The Waste Products of Agriculture -- Their Utilization as Humus**" by Sir Albert Howard and Yeshwant D. Wad, Oxford University Press, London, 1931
Where Howard's "An Agricultural Testament" charts a new path for sustainable agriculture, this first book is more a practical guide to making compost: how the Indore composting system which was at the foundation of the new movement was developed, and why. Full text online at the Soil and Health Library: http://www.soilandhealth.org/

"**Farming and Gardening for Health or Disease**" (The Soil and Health) by Sir Albert Howard, Faber and Faber, London, 1945, Devin-Adair 1947, Schocken 1972
This is Howard's follow-up to "An Agricultural Testament", extending its themes and serving as a guide to the new organic farming movement as it unfolded -- and encountered opposition from the chemical farming lobby and the type of agricultural scientists Howard referred to as "laboratory hermits". Together, the two books provide a clear understanding of what health is and how it works. Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

"**Sir Albert Howard In India**" by Louise E. Howard, Faber & Faber, London, 1953, Rodale 1954
Albert and Gabrielle Howard worked as fellow plant scientists and fellow Imperial Economic Botanists to the Government of India for 25 years, and this is a study of their work by Sir Albert's second wife Louise (sister of Gabrielle, who died in 1930). It's a classic study of effective Third World development work. Initially involved with improving crop varieties, the pair soon concluded it was futile to fiddle with seeds unless the work took full account of the system and circumstances as a whole. Thus developed a sustained interest in putting agricultural research into its right relation with the needs of the people, and a fundamental belief in peasant wisdom. Results were useful only if they could be translated into peasant practise. This led to the development of the famous Indore system of composting organic wastes: improved seeds were no use in impoverished soils. It's a great story. Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

"**The Earth's Green Carpet**" by Louise E. Howard, 1947, Faber & Faber, London
In this unusually clear book, Lady Howard (Howard wife), has written a "layman's introduction" which is also a work of literary distinction. Her subject is nothing less than the life cycle studied as a whole, and this leads inevitably to the importance of a reformed agriculture for the health of the community. She saw the need for a popular introduction to her husband's revolutionary ideas and principles, and her book draws a vivid picture of what lies behind the appearance of the Earth's green carpet. "Nature is not concerned to give us simple lessons," Lady Howard says -- and yet she transmits them here with admirable simplicity and clarity, a delight to read. Full text online at the Soil and Health Library:
http://www.soilandhealth.org/

Sir Albert Howard Memorial Issue, *Organic Gardening Magazine* (Vol. 13, No. 8), September, 1948. Howard died in England in October 1947 at the age of 74. Most of this issue of J.I. Rodale's *Organic Gardening Magazine* was devoted to his memorial. Five of the 15 papers in the issue are here presented in full (with thanks to Steve Solomon of the Soil and Health Library), including papers by Louise Howard, Ehrenfried Pfeiffer and Yeshwant D. Wad.

Howard on Earthworms -- Howard's Introduction to "The Formation of Vegetable Mould through the Action of Worms with Observations on their Habits" by Charles Darwin, Faber and Faber edition, London, 1945 -- 4,500-word article on worms and why they matter, also covers George Sheffield Oliver's work with earthworms in agriculture.
"The Formation of Vegetable Mould", full text online at the Soil and Health Library: http://www.soilandhealth.org/
"Friend Earthworm: Practical Application of a Lifetime Study of Habits of the Most Important Animal in the World" by George Sheffield Oliver, 1941, full text online at Journey to Forever.

Howard and Rodale -- Howard's Introduction to J.I. Rodale's "Pay Dirt -- Farming & Gardening with Composts" (Devin-Adair, 1946): "Everywhere knowledge increases at the expense of understanding. The remedy is to look at the whole field covered by crop production, animal husbandry, food, nutrition, and health as one related subject and then to realize the great principle that the birthright of every crop, every animal, and every human being is health."

Nutrition & Soil Fertility -- Howard's speech in support of the Cheshire doctors' "Medical Testament" when it was presented in 1939. From Supplement to "The New English Weekly," April 6th, 1939. Full text online.

Soil Fertility and Health by Sir Albert Howard -- From "Feeding the Family in War-time, Based on the New Knowledge of Nutrition" by Doris Grant, Harrap, London, 1942. A short and elegant exposition of the core concern of the Cheshire doctors' "Medical Testament".

Correspondence in the *British Medical Journal* -- Publication of the "Medical Testament" in the British Medical Journal drew some heated debate among readers in subsequent issues. This is a letter from Howard.

Soil Fertility: the Farm's Capital -- comments by Howard in discussion on a paper presented to the Farmers' Club by Sir Bernard Greenwell, "Journal of Farmers' Club," February, 1939, p. 9.

Quality of plant and animal products -- Sir Albert Howard: "Manufacture of Humus from the Wastes of the Town and Village": Lect. London Sch. Hygiene and Trop. Med. 17 June, 1937. Extract.

Humus and Disease Resistance -- Sir Albert Howard: "Insects and Fungi in Agriculture." Vol XV. No. 3. "Empire Cotton Growing Review." July, 1938. Extract -- 1,600 words.

Soil maintenance in the forest -- Sir Albert Howard: "A Note on the Problem of Soil Erosion." J. of Royal Society of Arts No. 4471, 29 July, 1938. p. 926. Extract.

How to Avoid a Famine of Quality -- Sir Albert Howard, Editor of *Soil and Health*, from *Organic Gardening*, Vol. II, No. 5, November, 1947: "Western civilisation is suffering from a subtle form of famine -- a famine of quality." (Scanned by Steve Solomon of the Soil and Health Library.)

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Weeds
Guardians of the Soil

by

Joseph A. Cocannouer

Author of Trampling Out the Vintage

The Devin-Adair Company
Old Greenwich • Connecticut

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Publisher's Preface

SO FAR as we are able to determine this is the first book to be written in praise of weeds. Many are the books which treat weeds as pests, and each season sees an advance in anti-weed campaigns and techniques; a host of chemicals, mechanical eradicators and even flame throwers are making life increasingly hard for nature's greatest and most widely dispersed group of plants -- the plants which stand condemned because they are deemed "out-of-place."

That the ordinary garden and roadside weed might have a vital function in the scheme of things and be of inestimable value to mankind seems not to have occurred to most agriculturists, whether in the classroom, the departments of agriculture or on the farm.

The author of this book has been teaching conservation and biology for close to fifty years. But he has been a student as well and a keen field man who has specialized in the ways of weeds, not only in his home state of Oklahoma where he has spent much time learning from the Indians, but in other parts of the world -- in Europe, India and the Philippines, particularly.

According to Joseph Cocannouer, weeds -- the common ragweeds, pigweeds, pusleys and nettles, to mention four -- perform the following valuable services among others:

1. They bring minerals, especially those which have been depleted, up from the subsoil to the topsoil and make them available to crops. This is particularly important with regard to trace elements.

2.When used in crop rotation they break up hardpans and allow subsequent crop roots to feed deeply.

3. They fiberize and condition the soil and provide a good environment for the minute but important animal and plant .life that make any soil productive.

4. They are good indicators of soil condition, both as to variety of weed present and to condition of the individual plant. Certain weeds appear when certain deficiencies occur.

5. Weeds are deep divers and feeders and through soil capillarity they enable the less hardy, surface feeding crops to withstand drought better than the crop alone could.

6. As companion crops they enable our domesticated plants to get their roots to otherwise unavailable food.

7. Weeds store up minerals and nutrients that would be washed, blown or leached away from bare ground and keep them readily available.

8. Weeds make good eating -- for man as well as for livestock. The publisher can vouch for the superiority of lamb's quarter -- a favorite of the author -- over any other domestic form of spinach or cooked greens.

No, Professor Cocannouer does not believe that weeds should be allowed to go rampant and take over our farms and gardens. The function of this book, a pioneering work, is to demonstrate how the controlled use of weeds can be sound ccology, good conservation and a boon to the average farmer or gardener.

D. A. G.

Next: 1. Weeds and Youth

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Pesticide residues in conventional, IPM-grown and organic foods: Insights from three U.S. data sets

by Brian P. Baker, Charles M. Benbrook, Edward Groth III, and Karen Lutz Benbrook

Published in: Food Additives and Contaminants, Volume 19, No. 5, May 2002, pages 427-446. 10 tables, 39 references.

Summary

Reducing dietary exposure to pesticide residues is an important goal of public health and environmental officials, farmers and other segments of the food industry, and consumers. Organic agriculture, with its strictures against the use of synthetic chemical inputs, seems to offer a low-residue alternative to conventionally-grown produce; avoiding exposure to pesticides is one major reason consumers buy organic foods. Foods sold with claims of reduced pesticide use or use of integrated pest management (IPM), sometimes certified as containing no detectable residues (NDR), are now on the market as well. In general, the effects of different agricultural production systems on dietary exposure to pesticides is a question of considerable interest to scientists, regulators and the public.

Surprisingly, few empirical analyses of residue data have addressed this question, mostly because of a dearth of data on residues in organic produce. In the absence of better data, public controversy has swirled about this issue, with conservative media commentators and critics of organic agriculture going so far as to suggest that foods grown organically have just as many pesticide residues as conventionally grown foods.

Sufficient good data now exist to resolve the issue empirically. The authors obtained data on pesticide residues in organically grown foods, foods produced with IPM/NDR

systems, and foods with no market claim (assumed to be conventionally grown) from three independent sources representing tests of over 94,000 food samples, and carried out statistical analyses of residue patterns.

Data Sources and Characteristics

We obtained test data from three U.S. sources: The Pesticide Data Program of the U.S. Department of Agriculture; the Marketplace Surveillance Program of the California Department of Pesticide Regulation; and private tests conducted by Consumers Union.

USDA Data: The USDA Pesticide Data Program collects samples of selected foods from a representative sample of retail outlets across the country. Samples are analyzed with sensitive multi-residue methods and specific methods for additional residues of interest, with extensive quality control steps and confirmation analyses. The PDP data are widely regarded as the best available data for assessing dietary pesticide exposure. We obtained PDP data for 1994 to 1999, which included 26,893 samples of 20 different crops. 127 of those samples were identified as organically grown, and 195 were identified as marketed with an IPM or NDR claim. The remaining 26,571 carried no recorded claim and were classified as conventionally grown for our analysis.

Cal DPR Data: California DPR testing is part of an enforcement program; as such, it needs rapid sample turn-around and relies on test methods with higher detection limits than those achieved by the USDA PDP. The DPR sampling strategy also emphasizes monitoring of potential problem areas, so its sampling is not precisely representative of all foods sold in California. But DPR tests large numbers of samples of multiple crops each year, and includes many organic samples. (DPR does not identify IPM or NDR samples.) We obtained DPR data for 1989 to 1998, which included results on 67,154 samples, covering 19 different crops; 1,097 of the samples were organically grown.

CU Data: Consumers Union conducted focused tests in 1997 designed to see whether there were differences in residues between organic, "green-labeled" and conventionally grown foods. CU tested only four crops, purchased in just six cities over a two-month period, so their sampling did not represent the broader US food supply. However, CU tested up to 20 samples of each crop from each market category, providing more samples of the selected organically-grown foods than either the PDP or DPR programs tested in any year. Analytical methods were comparable to those used by the PDP. CU's testing included 67 organic, 45 IPM or NDR and 68 conventionally grown samples.

Taken together, the three data sets provide an enormous amount of data on residues in conventionally grown samples of 20 major crops. The data also include 1,291 samples of organically grown foods and 240 samples with an IPM/NDR claim-enough to

support statistical analysis and comparison of residue patterns across the three market categories.

Analyses and Results

Raw data were obtained from USDA, Cal DPR and CU and converted to Access data files. We then computed number of samples, number with residues, number of residues per sample, mean residues, and other results of interest for individual crops and samples of each crop representing the different market sectors. A statistician performed various analyses to determine the statistical significance of observed differences.

Frequency of Positive Samples: All three data sets showed striking, highly statistically significant differences between market categories in the percent of samples that had at least one pesticide residue. Conventionally grown samples consistently had residues far more often than other categories. Overall, across 8 fruits and 12 vegetable crops, 73 percent of USDA's conventionally grown samples had residues. For five crops (apples, peaches, pears, strawberries and celery) more than 90 percent of samples had residues. Cal DPR (using less sensitive analytical methods) found residues in 31 percent, and CU found residues in 79 percent, of their conventionally grown samples. Organically grown samples consistently had far smaller percentages with residues: 23, 6.5 and 27 percent in the USDA, DPR and CU data, respectively. In the two data sets that included samples of the third category, residues were found in 47 percent of the USDA IPM/NDR samples and 51 percent of the CU IPM/NDR samples.

We performed a second analysis of the USDA data from which we excluded residues of long-banned, environmentally persistent chlorinated organic insecticides, such as DDT, dieldrin and chlordane (i.e., residues due to environmental contamination rather than to differences in crop production methods). With these residues excluded, the fraction of positive organic samples dropped from 23 to 13 percent. The effect of excluding these residues on percents positive in other categories was much less noteworthy (conventional dropped from 73 to 71 percent, and IPM/NDR dropped from 47 to 46 percent.)

Multiple Residues: Conventionally grown foods often contain residues of more than one pesticide. A conventionally grown apple tested by USDA in 1996 was more likely to contain four or more residues than to contain three or less, and some individual samples have been found with as many as 14 different residues. We examined the frequency of multiple residues and again found highly statistically significant differences between the market categories. Conventionally grown samples had multiple residues in 46, 12 and 62 percent of USDA, DPR and CU samples, respectively. Organic samples had multiple residues in only 7, 1.3 and 6 percent of the samples in those three data sets. IPM/NDR samples were again intermediate, at 24 percent (USDA) and 44 percent (CU).

Residue Levels: We compared residues of the same pesticides found on conventional, organic, and IPM/NDR samples of the same foods. This analysis was somewhat limited by the relative rarity of residues on organic samples, but comparable residues were lower on organic samples about two-thirds of the time in all three data sets. When data from all three sources were combined, the difference was statistically significant. Comparison of residues in IPM/NDR and conventional samples from the USDA data set found residue levels in the former were also significantly lower than those in the latter.

Discussion

Our analysis shows convincingly that organically grown foods have fewer and generally lower pesticide residues than conventionally grown foods. This pattern was consistent across all three independent data sets. Organic foods typically contain pesticide residues only one-third as often as conventionally grown foods do. Foods marketed with an IPM or NDR claim fall in between organic and conventional foods in both the frequency of residues and residue levels. Organic samples are also far less likely to contain multiple residues than conventional or IPM/NDR foods are.

While the risks to health associated with dietary pesticide residues are still uncertain and subject to debate, risk is relative, and lower exposure undoubtedly translates into lower risk. Consumers who wish to minimize their dietary pesticide exposure can do so with confidence by buying organically grown foods.

Our analysis does show, however, that organic foods are not pesticide free. Most of the residues in organic foods (and some of the residues in conventional foods as well) can readily be explained as the unavoidable results of environmental contamination by past pesticide use, or by "drift" (sprays blown in from adjacent non-organic farms). Some foods sold as organic may also be mislabeled, either because of fraud or because of lapses in maintaining the identity of foods as they move from the farm to the consumer.

A potentially significant gap in this analysis is the lack of data on natural pesticides, used by some organic farmers and some non-organic growers as well. Included are botanical insecticides such as rotenone and pyrethrum, sulfur and copper compounds, and a variety of other traditional pesticides permitted in organic agriculture. Some commentators have suggested that residues of these natural pesticides are present in organic foods and offset the absence of residues of conventional crop chemicals.

We examined that issue and conclude that there is no objective evidence to support the assertion that natural pesticide residues pose a hazard. None of the test programs from which we obtained data include data on natural pesticide residues; in fact, there are few analytical methods available to detect these substances. The botanical insecticides tend to break down rapidly in the environment, are comparatively

non-toxic, and are used by a relatively small fraction of growers, ordinarily only as a last resort. Consequently, these substances are not expected to leave residues in foods. They are therefore exempt from tolerances (residue limits) as set by the U.S. Environmental Protection Agency, and no agency routinely tests for them.

The possible risks posed by natural pesticides is an interesting question that should be pursued with both better residue data and more extensive toxicity testing of some of the natural substances. However, there is currently no objective evidence of a problem with residues of natural pesticides, whereas the health risks associated with conventional pesticide residues in foods are well-established and substantial and subject to intensive regulatory efforts aimed at reducing exposure.

While our analysis shows that organic foods clearly have much fewer pesticide residues than other choices on the market today, it also suggests several opportunities for organic growers and others to further reduce residue levels. More steps can be taken to test for and avoid contamination by persistent residues in soils. Enforcement of the new USDA national organic standards should reduce the (relatively rare) incidence of mislabeling, and ensure that consumers who buy organic get what they pay for.

Graphic presentations of key findings (13 Charts):
http://www.omri.org/OG_chartsgraphs_final2.htm
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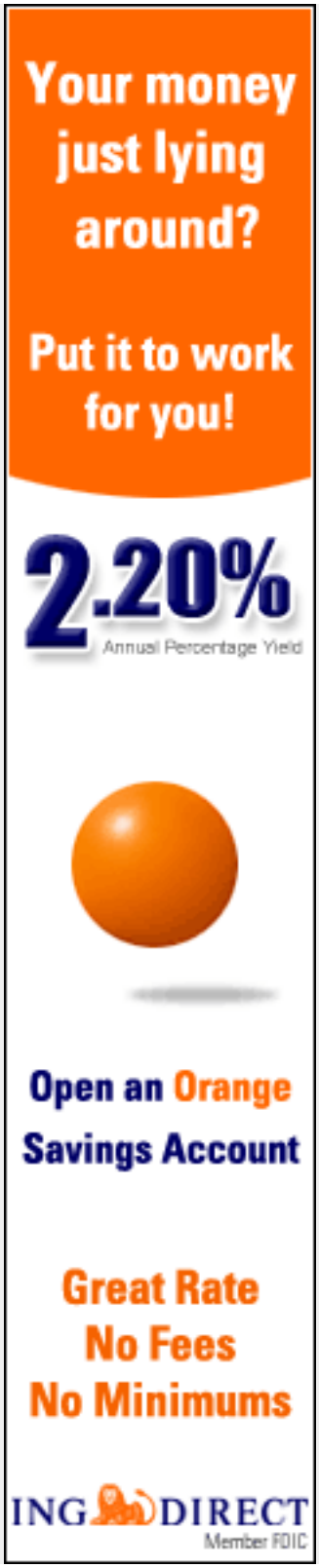

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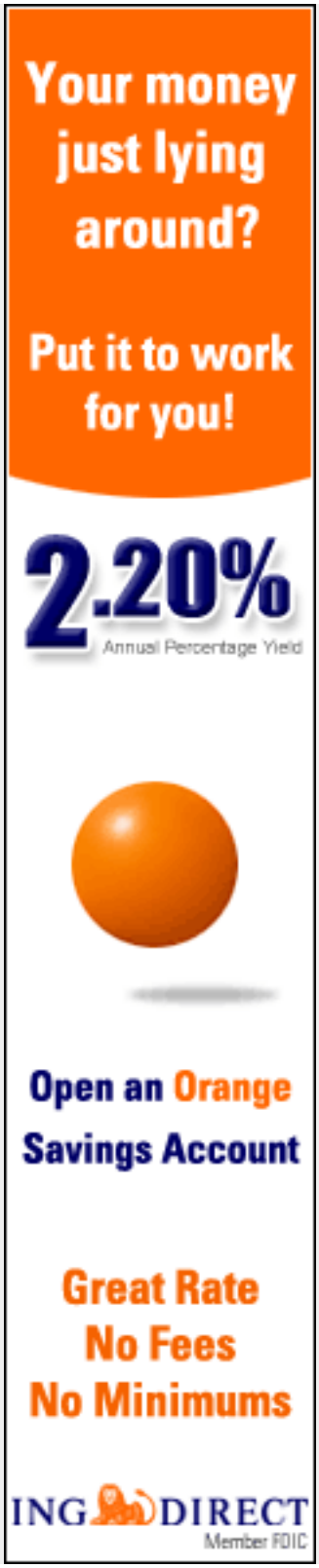

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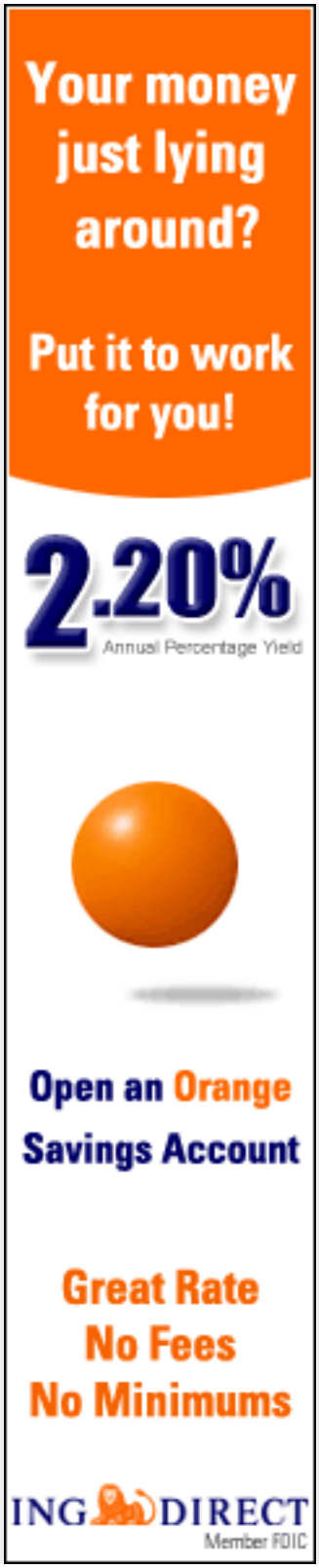

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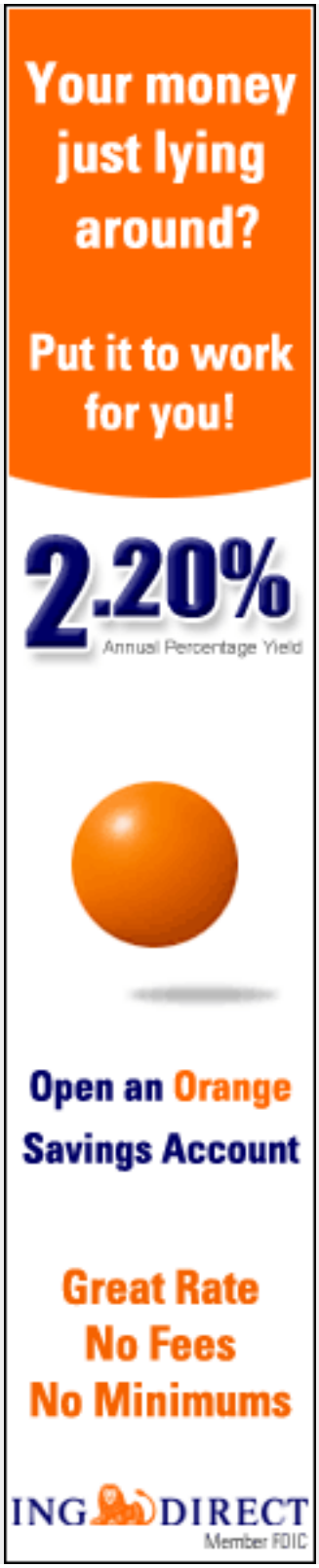

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Is Organically Grown Food More Nutritious?

Virginia Worthington / The Co-op Connection Nov01

Also by Virginia Worthington:
Nutrition and Biodynamics: Evidence for the Nutritional Superiority of Organic Crops
Biodynamics v.224, Jul/Aug99

There are many difficulties in assessing the nutritive value of organic vs. conventionally produced foods. The first is that the difference in terms of health effects is not large enough to be readily apparent. In other words, if people stayed well on an organic diet but got violently ill as a result of consuming food grown with chemical fertilizers and pesticides, then the difference would be perfectly obvious; however, this is not the case, and a more subtle difference, such as an 8% increase in the incidence of allergies, for example, is much more difficult to detect and easier to overlook.

A second reason is that it is difficult to conduct and interpret agricultural research investigating nutrient content. Factors such as sunlight, temperature and rainfall, which influence the nutrient content of plants, vary from year to year. Additional changes in the nutrient content of a crop can occur during storage and shipping. For these reasons, it is difficult both to plan effective studies and to make sense of the results. Furthermore, these considerations often make it difficult to compare the results of different studies.

Finally, many of the studies that have been done are relatively old and not performed according to modern standards. In particular, the older studies do not include a rigorous statistical analysis. This factor alone can make these studies difficult to evaluate. As a result, they have been dismissed by some as valueless.

What is the evidence?
There are more than 30 studies comparing the nutrient content of organic crops and those produced conventionally with chemical fertilizers and pesticides. In these studies, various individual nutrients in individual crops were compared, such as zinc in organic versus conventional carrots, or Vitamin C in organic versus conventional broccoli. In the more than 300 comparisons performed in these studies, organic crops had a higher nutrient content about 40% of the time, and conventional crops had a higher nutrient content only about 15% of the time. Overall, organic crops had an equal or higher nutrient content about 85% of the time. These results suggest that, on average, organic crops have a higher nutrient content.

For three individual nutrients — Vitamin C, nitrates and protein quality – there is enough evidence to suggest that organic crops are superior to conventional ones. Compared to crops grown with chemical fertilizers and pesticides, organically grown crops generally have a higher Vitamin C content, a lower content of carcinogenic nitrates and better protein quality. Further work is needed on other nutrients before any definitive conclusions can be drawn.

The most relevant studies are not those that simply assess nutrient content, but are those that feed organic or conventional feed to animals and then look at how healthy they are. There are 14 such animal studies that have been performed over the last 70 years. In ten of these, the organically- fed animals fared better; in one, the animals fed organic feed came in second among several

chemically-fertilized feeds; and three studies showed no difference, possibly due to weaknesses in the study designs. The positive effects are most striking in sick or otherwise vulnerable animals such as newborns and in sensitive areas of reproduction such as sperm motility.

It is particularly interesting to see that the fertility of animals fed fodder grown with chemical fertilizers and pesticides declined over several generations.

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A complete version of this article entitled, "Effect of Agricultural Methods on Nutritional Quality: A Comparison of Organic with Conventional Crops" by Dr. Virginia Worthington, appeared in Alternative Therapies, Volume 4, 1998, pages 58-69.

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Nutrition and Biodynamics: Evidence for the Nutritional Superiority of Organic Crops

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Also see:
Is Organically Grown Food More Nutritious?
Virginia Worthington / The Co-op Connection Nov01

Virginia Worthington MS, ScD, CNS

While it is generally acknowledged that pesticide residues in food and drinking water may be a bad thing, the conventional wisdom still holds that organic food is no more nutritious than conventionally grown food. A stunning lack of interest on the part of government and university researchers is in large part to blame for this situation. What is behind claims about the nutritiousness of organic food and how does biodynamic food stack up against the rest of the pack? Let's take a look at the evidence.

There have not been a huge number of researchers that have even considered the influence that agriculture methods might have on human or animal nutrition. Nevertheless, there have been at least thirty-five studies comparing the nutrient levels of organic and conventional crops. Few of these studies are directly comparable. Some look at only fertilizers and others at farming systems such as biodynamics; some examine freshly picked produce at the farm gate while others look at crops that have been in storage or have been shipped to market. Moreover, taken individually, few of the studies show conclusive evidence one way or the other. As a consequence, it is easy to walk away thinking that there is no significant difference.

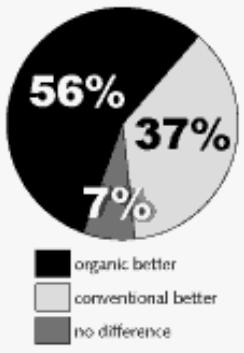
However, when the nutritional comparisons are piled up together and we ask the right questions, a different picture emerges which suggests that organically grown crops are more nutritious. In the following sections, we will ask a few of these questions with regard to the body of published comparisons, and along the way see how well biodynamic crops compare both to conventional and to other organic crops.

How often is organic better?
This first question deals with how much of the time organic crops have a better nutrient content than similar conventional crops. This is an important questions because it tells how likely a consumer would be to come across an organic food item with higher nutrient levels or lower levels of toxic substances. A rough answer to this question can be obtained by looking at the numbers in the published studies, and sorting the comparisons by outcome - organic with a higher nutrient content (or lower for toxics), conventional higher, or both exactly the same.

Figure 1 shows the results of this process: the organic crop has the higher nutrient level or lower toxic level in 56 percent of the comparisons while the conventional crop was better only 37 percent of the time. For biodynamic crops, the numbers are similar with the biodynamic crop having a better nutrient content 59 percent of the time and the conventional crop 27 percent of the time. These results are significant since the organic crop has the better nutrient content the majority of the time. Overall this pattern suggests that any nutritional benefits that organic food might offer would occur often enough to be useful to a consumer and that biodynamics has a slight edge in that regard.

How much better is organic?
The second question asks how much more of each nutrient is there on average for organic crops versus conventional crops. The average percent more or less for some nutrients is shown in Table 1 below. Over a number of nutrients in the crops that have been studied, the average organic crop has approximately 10-20 percent higher nutrient levels than a comparable conventional crop. For toxic substances, there are not many studies except for nitrates, but it appears that, on average, the organic crop has at least 10-20 percent less toxics.

Figure 1. Organic versus conventional
Percent of 1230 published comparisons where nutrient levels are better, worse or the same



How do biodynamic crops compare to other organic crops in terms of nutrient levels? There are too few biodynamic studies to answer this question in any meaningful way for most nutrients. Nonetheless, we can do a preliminary evaluation. Table 1 shows the average difference in nutrient levels for both biodynamic and other organic crops. Of the nutrients shown in Table 1, only vitamin C has been studied to any extent in biodynamic crops, and vitamin C levels appear to be higher in biodynamic crops compared to other organic crops. Otherwise, from the small quantity of existing data, biodynamic crops appear to

be reasonably similar to other organic crops.

We have seen now from this analysis that organic crops have higher levels of nutrients the majority of the time. Still, it is easy to dismiss all of this as insignificant since the absolute quantities of nutrients are small. For example, if there is 47 percent more vitamin C, for most foods that amounts to no more than a few milligrams. Are these small differences of any consequence? A few years ago it would have been easy to brush them aside, but it is now known that there are many nutrient interactions and that small differences do matter.

For example, an increase in vitamin C increases the effect of vitamin E, folic acid and iron. The increase in vitamin E then increases the effect of selenium and vitamin A. Vitamin A further increases the effect of iron, and so on. Because of these interactions, small increases (or equally decreases of toxic substances), over the many nutrients in a food, can have a much bigger effect than would be expected from looking at the individual nutrient levels. Nutritionally speaking, the whole is greater than the sum of the parts. And small differences in nutrient levels can matter a lot.

Table 1. Average difference in nutrient levels
***Biodynamic, non-biodynamic and all organic crops compared to similar conventional crops**

Nutrient	Biodynamic % difference	Other organic % difference	All organic % difference
vitamin C	+47.6%	+11.9%	+22.7%
Iron	+33.9%	+15.6%	+17.2%
calcium	+07.4%	+38.4%	+30.8%
Phosphorus	+06.6%	+14.3%	+12.5%
sodium	+20.3%	+19.3%	+19.6%
Potassium	+07.9%	+16.2%	+14.1%
Magnesium	+13.2%	+28.3%	+24.4%
beta-carotene	+14.0%	-09.2%	-00.3%
Nitrates	-49.8%	-30.9%	-33.9%

*All nutrients that have been measured in biodynamic crops are included.

Does organic food make you healthier?
This brings us to the most relevant question: what happens to the health of animals and humans eating organic foods? There are no human studies to look at, but there are reports of positive health effects from consumption of organic foods. One published report tells of the improved health of students at a boarding school that began serving organically fertilized fruits and vegetables. Other reports come from doctors, administering alternative cancer treatments, who have observed that a completely organic diet is essential for a successful outcome.

As for formal investigations, there are fourteen animal studies comparing organic with conventional feed. Biodynamic studies are shown in Table 2 and other organic studies in Table 3. What is striking about the studies as a whole is that there are eight studies where the organically fed animals performed significantly better and no studies where the conventionally fed animals performed much better. In addition, the three studies showing no difference had methodological problems that made them unlikely to find one. In these studies, animals were either supplemented with vitamin A or fed high vitamin A feed and then judged on outcomes which would be affected by this vitamin.

The positive studies showed that organically fed animals had less illness, better recovery from illness, better testes condition and greater sperm motility in males, greater egg production in females, better fertility, fewer stillbirths and perinatal deaths, and better survival of young. These outcomes, reproduction and incidence and recovery from illness, are sensitive indicators of health status, and should be given appropriate weight. Taking all of this into account, the available data is very strong with regard to the health benefits of organic feed.

Of the strongly positive studies, the majority used biodynamic feed, and all of the biodynamically fed animals performed excellently compared to conventionally fed animals. All of the biodynamic studies were clearly positive. Non-biodynamic studies, on the other hand, showed more mixed results, with some studies being extremely positive and others showing a less clear cut benefit. Altogether, these results suggest that while a number of organic systems may be capable of producing positive results, biodynamics at the very least provides a model for a healthy agricultural system.

Table 2. Animal studies comparing biodynamic with conventional feed

Study	Outcome
Pfeiffer, 1938 cited in Linder, 1973	earlier (166 vs 181 days of age) & greater egg production (192 vs 150 eggs per hen) in chickens fed biodynamic versus conventionally fertilized grain. Spoilage of eggs after 6 months was 27% for biodynamic eggs versus

	60% for conventional eggs lower mortality (9% vs 17%) in weanlings fed biodynamic wheat versus conventionally grown wheat
Aehnelt & Hahn, 1973	greater number of eggs (8.6 vs 1.8 & 0) and higher fertilization rate (93.1% vs 0% & 0%) in rabbits fed biodynamic versus conventionally fertilized feed
Staiger, 1986 cited in Vogtmann, 1988	fertility rate of rabbits remained constant over 3 generations with biodynamic feed and declined with conventionally grown feed
Plochberger, 1989	better weight gain after coccidial illness & fewer incidents of illness in chickens fed biodynamic feed; significantly higher egg weight and yolk weight in chickens fed biodynamic feed compared to birds fed chemically fertilized feed
Velimirov et al, 1992	fewer stillbirths and perinatal deaths in first litters and better weight maintenance in lactating female rats fed biodynamic feed versus conventional feed

Table 3. Animal studies comparing non-biodynamic organic with conventional feed

Study	Outcome
McCarrison, 1926	less weight loss (22.4% vs. 37.4%) & longer survival (50 vs 33 days) in birds with polyneuritis fed a manure fertilized millet supplement versus birds fed a chemically fertilized millet supplement higher weight gain (77.7% vs 51.4%) in young rats fed manure- versus chemically-fertilized wheat
Rowlands & Wilkinson, 1930	greater weight gain in vitamin B deficient rats fed a manure fertilized seed supplement versus rats fed a chemically fertilized seed supplement
Harris, 1934	duration of cure for bradycardia in rats was 6, 5 and 4 days when fed grain fertilized with ammonium sulphate, manure, and complete chemical fertilizer
Leong, 1939	duration of cure for bradycardia was similar or longer for rats fed wheat (5.0 vs 5.4, 5.2, 5.1 days) or barley (8.1 vs 5.3, 4.8, 4.7 days) from fields treated with manure versus complete chemical fertilizer, ammonium sulphate or both
Swanson, 1940	no difference in growth in vitamin A depleted rats supplemented with sweet potatoes fertilized with manure, muriate of potash, nitrate of soda or superphosphate
Miller & Dema, 1958	no difference in reproduction in rats
Scott et al, 1960	less testes degeneration & similar reproductive performance in mice fed manure-fertilized wheat versus conventional feed
Aehnelt & Hahn, 1973	reduced sperm motility in bulls transferred from organic to conventional fodder; motility restored when organic fodder resumed
Gottschewski, 1975 cited in Vogtmann, 1988	mortality of newborn rabbits was 27% for animals fed organic feed versus 51% for those fed conventional feed and 50% for those fed commercial pellets
McSheehy, 1977	no difference in reproduction in mice

Is there any more evidence?

A final point is that there are known mechanisms and scientific explanations for the observed differences in nutrient levels. A portion of the difference is due to effects of fertilizer. The soil dynamics and plant physiology that would produce some of the observed nutritional differences are known. For example, the excessive quantities of nitrogen presented to the plant by chemical conventional fertilizers cause the plant to produce more nitrates, less vitamin C and a poorer quality protein. Similarly, conventional potassium fertilizers make soil magnesium less available to plants so that levels of this nutrient are

lower in potassium fertilized plants.

In addition, pesticides are known to affect plant composition, and there are a few studies showing nutritional effects. Herbicides are particularly nasty in that they kill plants by altering their production of key compounds such as beta-carotene, tocopherols and amino acids, all of which have nutritional significance. Although food crops are not killed by herbicides, the nutritional composition of these crops may still be altered. For example, the few studies that examined the effects of herbicides on protein, all showed a decline in protein quality with herbicide usage.

A complete exposition of the science behind the nutritional effects of agricultural chemicals is well beyond the scope of this article, but nonetheless, the fact that these chemicals are known to affect the nutrient composition of plants should not be forgotten.

Conclusion

Where does this leave us? We have seen a pattern of better nutrient composition in organic crops, better health in animals consuming organic food and the existence of known mechanisms explaining observed differences between organic and conventional crops. Biodynamic crops performed extremely well on the most important measure, the health of consumers. Whatever problems there may be with the quantity or quality of existing studies, the body of evidence, at a minimum, provides strong indications that organic crops are more nutritious.

Appendix: analytical methods

This analysis used all studies, available to the author, comparing crops produced with organic fertilizer or by organic farming systems to conventional fertilizers or systems (see sections 1and 2 of the references). Studies of research plots, pot studies, farm gate produce, stored produce and produce purchased at markets were all included. The reason for this is that there are insufficient data of any one type to draw meaningful conclusions. Consequently, all the data was considered. Fertilizer studies were used because differences in fertility management are historically the most fundamental difference between organic and conventional agriculture. In addition, fertilizer effects are often ignored in the furor over the toxic effects of pesticides.

For purposes of this analysis, a single comparison consisted of a single nutrient in a single organic vegetable crop grown in one growing season compared to the same nutrient in the same conventionally grown crop grown in the same season. A few studies reported pooled comparisons that included more than one year or more than one crop. These comparisons were included in the analysis when single comparisons were not available.

To produce Figure 1, all available published comparisons (n=1230) were sorted by outcome. The three outcome categories are:

1. organic with a higher nutrient level or a lower level of a toxic substance
2. conventional with a higher nutrient level or a lower level of a toxic substance
3. both the same.

This sorting was done by the numerical values or by the stated outcome for studies where no numbers were published. Statistical significance of differences was not considered.

The percentages in Table 1 use the conventional crops as the standard or 100% so that a difference of +10 means that organic crops have on average 110% of the conventional level for the same nutrient. Only studies that contained numerical values were used for this part of the analysis. The percentages were calculated by first calculating a percentage difference for each nutrient within a study. For each nutrient, the percentage differences by study were averaged. In a few cases, a study included both biodynamic and other organic comparisons. Separated averages were calculated for these groupings.

The number of studies and comparisons for each nutrient used in Table 1 is shown in Table A-1 below:

Table A-1. Number of studies and comparisons for nutritional factors classified by biodynamic or non-biodynamic status

	Non-biodynamic		Biodynamic	
Nutrient	No. of studies	No. of comparisons	No. of studies	No. of comparisons
nitrates	16	144	3	27
beta-carotene	9	24	3	15
vitamin C	17	92	5	39
iron	14	77	1	7
magnesium	14	73	2	24
phosphorus	14	75	2	22
calcium	14	72	2	22

sodium	9	41	2	19
potassium	13	70	2	22

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Ken Hargesheimer

Teaching organic, biointensive, raised-bed gardening, market gardening, mini-farming and mini-ranching worldwide.

Ken?

Where is he going this time?

Raised Bed Agriculture

- Food Production
- Traditional & Historic
- Five Principles
- Benefits
- Applications
- New Crops
- Urban RBA
- Rural RBA

For home gardening raised bed agriculture means: less work, less irrigation, improved soil, higher yields and no poisons. For market gardeners, mini-farmers and mini-ranchers it means all the above plus profits. People can have a comfortable income, a high quality lifestyle, provide a great service to their community and it's a great way to raise children.

RBA creates a healthy soil to grow healthy plants to provide healthy food to feed healthy people. For the human population to be healthy, we need to consume healthy foods [organic] which come from healthy animals eating healthy plants grown in healthy soil [C Scheaffer, VMD/holistic].

Health:
People suffer due to very poor diets. The greatest benefit of RBA isn't the increased yields but the better nutrition provided to the families. This reduces their medical needs tremendously.

Food Production:

Agriculture is in a crisis worldwide. The Green Revolution is not ecologically sound, economically viable or socially responsible. The "Green Revolution", which attempted to impose inappropriate crops and techniques in the Andes, has been a miserable failure. [The same is true around the world. KH] Srs. I. Garaycochea and J. Palao refer to the remains of twisted windmills, cracked irrigation canals and rusted out tractors littering the rural countryside as the "archaeology of development". It is ironic that the groups promoting the Green Revolution had to destroy ancient agriculture fields, to introduce the inappropriate technology and capital-intensive farming practices.

> "The prehispanic raised fields are classified on government maps "for wildlife use only". It is a good thing that those ancient farmers didn't have access to those maps!"
> C. Erickson, UPA.

The Green Revolution makes farmers depend on, even economic slaves to, agribusiness and multinational corporations: Cargill\Monsanto, ConAgra, Novartis\ADM and others. Their goal is to increase profits and to control the world's food supply from research to production to consumer by controling seed, fertilizers and chemicals. These seeds must have chemicals sprayed on them to produce and the seed can not be saved for the next crop.

> "These companies tell the US patent office that the plants are novel and unique to get a patent but they tell the FDA/EPA that that they are natural and not new and not subject to regulations." [S. Ogden, Straight-Ahead Organics, 1999].

Other corporations are beginning to market irradiated food which may be dangerous to our health. Most governments, USAID, most ag extension services and ag universities in most countries help the companies by promoting the use of their products. They are more interested in export crop production than in food crops to feed local people.

> "If I had taken what I learned about agriculture at Texas A & M University to a third world country, I would have starved to death". Mike Sullivan, ECHO, Ag Missions Conference 1998, quoting his son.

The world's farmers can produce all the food the world's population requires, regardless of how high it goes, using RBA.

Note: A salesman promotes chemical fertilizers, insecticides, herbicides, etc and gets paided by the chemical company from the sale. Promoters of organic gardening and farming have nothing to sell.

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Raised Beds: Traditional & Historic

They were used in Asia [Indonesia, China, Vietnam, PNG], Latin America [Mexico, Guatemala, Bolivia, Peru], Europe [France] and USA [Indians] for centuries. They are now being used in Kenya, Nigeria and a few other countries. I saw a few in the 60's while living in Guatemala. They are being restored in Peru and Bolivia.

> "It was proven that labor costs were low, harvests were bountiful, production was sustainable and the technology could be managed by individual families using available tools." [Bolivia] C. Erickson, UPA.
>
> On the Web:
> http://www.sas.upenn.edu/~cerickso/applied.html
> http://archaeology.about.com/msubfarm.htm
> http://archaeology.about.com/blinterviews.htm

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Five Principles of RBA:

Regardless of the quality of the land, these principles will make it highly fertile.

1. Maximize organic matter production
2. Keep the soil covered
3. Use zero tillage
4. Maintain biological diversity
5. Feed plants through the mulch.
   Roland Bunch, COSECHA

Organic:
All gardeners and farmers were organic until the use of chemicals in WW II [to kill people then, insects now]. They kill soil micro-organisms and worms. No one has the right, moral or legal, to poison the air, soil or water.

> "Organic gardening and farming is more than avoiding chemicals. The organic method requires a change of attitude and a different thought process." [H. Garrett, DMN]

RBA does not require the purchase of any outside inputs. The present generation knows nothing about raised beds or organics because their fathers and

grandfathers have used chemicals since the 1950s. Therefore, they must be taught.
[Read: From The Good Earth, by M. Ableman, http://www.dirtdoctor.com]

RBA allows people to feed themselves on a local basis that provides total community food security and is a proven food production system that is ecologically sound, economically viable, socially responsible and Biblically based.

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Benefits of RBA:

A. Organic, biointensive, double dug, permanent raised beds which can double or even triple the yield while reducing the labor by half compared to traditional gardening. Using this, a family can grow all their food for a vegetarian diet on 300 MÂ². http://www.bountifulgardens.org
This works [USA: Chadwick Garden & market garden, Ecology Action; CET, Chile; Manor House Ag Center, Kenya; ECOPOL, Mexico; IIRR, Baptist Rural Life Center, Philippines] and the proof is there for all to see. This is used by home gardeners and small market gardeners.

B. Organic, permanent raised beds can increase yields, stop erosion and reduce labor. Land sloping up to 75% can be farmed without erosion. I saw them in Honduras after hurricane Mitch. This works [COSECHA & CIDICCO, Honduras; M Fukuoka, Japan; Centro de EducacÃ-on y TecnologÃ-a, Chile; IIRR, BRLC, Philippines; M Cain, USA; Vietnam: VACVINA] and the proof is there for all to see. [read Plowman's Folly, by E. H. Faulker; Weeds-Control Without Chemicals, by Walters. Video: Necessity of Organic Resides, by R. Parnes]. This is used by home gardeners, market gardeners and mini-farmers.

Hand labor with hand tools is used such as hoes, shovels, rakes, digging forks, machetes. Hand tools: Scythe - cuts grass, harvest grain; Hedge clipper - long handles for trimming/cutting back growth of hedges, trellises, etc; Lopper - long handles for cutting limbs; Wheel Hoe - walk-behind with various implements; Planter - walk-behind which drops seed; Spreader - walk-behind which spreads fertilizer, etc.

The above boasts two advantages which no other production system can claim.

> First, it is easier on the soil than mechanized methods. Second, it is the least expensive method in terms of capital outlay. For mini-farms this method is not only economically viable but superior to the alternatives. Jeff Rast, Countryside, Nov/Dec 98.

C. Alley-cropping: Raised beds between rows of trees [food, oils, chemicals, medicinals, spices, beverages, crafts, lumber, forages, firewood, windbreaks, industrials, etc] which are a planned crop.
http://www.winrock.org
http://www.treesftf.org
http://www.unl.edu/nac
This works and the proof [USA; Nigeria, IITA; Philippines, IIRR, BMRLC; Costa Rica] is there for all to see.

Bucket drip irrigation kits should be used during the dry season or in areas of low rainfall. The kit [US$15 + Postage & Handling] irrigates 200 feet of vegetables by filling a five gallon bucket each morning and each evening. Two kits will produce all the vegetables needed for a family of seven on a vegetarian diet [Kenya]. Bucket drip kits can be adapted to use with trees. [video: Third World Irrigation Update, free with first kit or US$5 ppd.]

Seed:: Use open pollinated, organically grown if possible. Save your seed. Exchange with others. http://homepage.tinet.ie/~merlyn/seedsaving.html

RBA can be used to produce flowers, dyes, vegetables, nuts, fruits, trees, grains, fibers, herbs, spices, medicinals, oils, teas, sweeteners, fragrances, crafts, seeds, ornamentals, bamboo, industrials [lubricants, brooms, gums, waxes, oils, rubber, emulsifiers, paper], forages, feed grains, animal medicinals, livestock. http://www.echonet.org

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RBA Applications:

Use one or more of the methods outlined as they apply to your situation.

1. Home Garden/Mini-Ranch: Every home should have a garden to produce food for the family. This assures that the family, especially the children, do not consume chemicals. With little land, double dig for highest production. Additional beds can be used for forages for micro-livestock and/or small farm animals and/or regular livestock. Use moveable pens or use cut and carry.
   [Grow Food & Feed, by E. Omondi, US$10 ppd.]
2. Market Garden: High value, labor intensive crops. Double dig for highest yields.
3. Mini-Farm: Additional crops requiring more land but less intensive labor. Some are particularly adapted to value-added.
4. Mini-Ranch/Mini-Dairy: Use raised beds for forage/grain. Small animals are in pens which are over the beds and moved down the bed daily for grazing or use cut and carry. Micro-livestock [hampsters in the kitchen, etc.] to small livestock to cattle are grown.

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New Crops, Livestock, Marketing Ideas

Crops:
I am constantly searching for new crops and new marketing ideas for mini-farmers. The following at successful in one or more countries and many can be a cottage industry. I am seeking sources for seed. The following all vary in regard to climate, soil, etc.

New Food Crops:

1. Stevia. In great demand by diabetics and weightwatchers. It is a small bush whose leaves are 25 times sweeter than cane or beet sugar. Non-caloric. Cottage industry.
2. Crotalaria [sunhemp]
3. Sweet Sorghum cane and syrup [USA]
4. Naturally colored cotton [Peru].
5. Tomatillo [Mexico]
6. Rice: African, Floating
7. Bambara groundnut
8. Beans: Winged, Velvet, lablab, tropical lima
9. Grains: quinoa, ammarath, buckwheat, Teff, Spelt, Emmer, Ethiopian barley; Finger millet, Pearl millet: popping [India]

10. Sorghum: popping, vegetable, red dye [India]
11. Maize: sweet, parching; Kamut; Perennial wheat;. Fonio/Acha [world's best tasting cereal!]

Industrial Crops:

1. Broomcorn, brooms [USA]
2. Purple maize shucks for crafts,etc
3. Industrial hemp

Livestock:
Raise animals that use forages and non-human food. Use the old native breeds of livestock who do well on forages. Use three-way cross.

1. Muscovy ducks- No housing needed; little food; eats flies out of air;
2. Quail - Major source of meat in some areas.
3. Water buffalo - milk producer, cheese.
4. Rabbits, Angora - hair for weaving
5. Miniature livestock - 15 breeds available. Several countries have native miniatures.

Value-added:

1. Grains, stone ground
2. Oil seed, cold pressed

Marketing:
There is a worldwide, grassroots movement to buy local, buy fresh and buy organic.

1. Farm stand or curbside stand: Customers coming to you is low cost marketing. People will drive to a farm to buy fresh food.
2. Farmer's Markets: They are in every country from one day per week to several days per week. Three days per week is best. They are the fastest growing means of marketing today
3. CSA-Community Supported Agriculture: Customers pre-purchase shares of produce.
4. Cooperatives: Enables the mini-agriculturists to work together to do what they can't do individually in marketing and/or value-added processing. [example-cheese making, jelly, etc]
5. Cottage industries/value-added: Use family labor to process in some way what is grown to increase the selling price. Examples: solar dried fruit/vegetables, jams/jellies, crafts, milk/cheese, dried flowers, etc. [equipment manufacturers: Cecoco, Japan]. I visted the farm of a woman in Honduras who grows, harvest, hulls, roast and bags her own coffee. She markets it only in her own community.

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Urban RBA:

RBA has the potential to provide many benefits to cities - in nutritional improvement, hunger reduction, income generation, enterprise development and environmental enhancement. The poor and unemployed can grow their own food. Farming converts degraded and unkept vacant lots into healthy, green areas. Waste [grass, leaves, trees, sawdust, manure, food waste] can be composted and used on the farms. City governments must recognize the potential of urban agriculture and accord it the status given to other industries and economic activities in the city. Urban Ag Network: URBANAG@compuserve.com; Read: Urban Agriculture: Food, Jobs and Sustainable Cities; A Patch of Eden, H P

Hynes, 1996. Cultivating Havana: Urban Agriculture. 1999, Food First. 25% to 75% of all the food consumed within the large cities is produced within those cities.

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Rural RBA:

Much of the land farmed by small, family farmers is usually the worst available: in the tropics the land may slope up to 75°, has been mined of its nutrients and the farmer has no choice. RBA is the answer: no or little outside inputs are needed and only family labor. In Honduras, land with a 73° slope, using raised beds, had no eroison during hurricane Mitch.

> "A difference is noticeable in even one year [using raised beds]. Terracing, rock walls, grass/tree borders, etc are not necessary. The beds plus green manure/cover crops/mulching controls erosion. When widely adopted, it generates sufficient income to stop immigration to the cities, raises land values and community health improves." [COSECHA].

People must understand that being a farmer, a granjero, fazendeiro o campesino, a fermier is honorable.

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The Official Site of Square Foot Gardening
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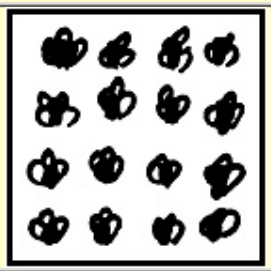
Plant Spacing

HOW TO SPACE PLANTS IN A SQUARE FOOT GARDEN

Extra Large	Large	Medium	Small
			
1 Plant 12 in apart Broccoli Cabbage Pepper	4 Plants 6 in apart Leaf Lettuce Swiss Chard Marigolds	9 Plants 4 in apart Bush Beans Spinach Beets	16 Plants 3 in apart Carrots Radishes Onions

Once you have your square foot grid in place, this is the easiest way to learn the perfect spacing for all your plants. All plants, vegetables, flowers, or herbs, will fit either 1 – 4 – 9 – or 16 plants per square foot depending on how big they get.

Look in the Square Foot Gardening book for the correct spacing of all the vegetables or just figure it out from the seed packet directions.

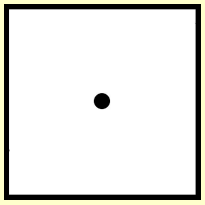
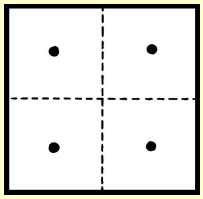
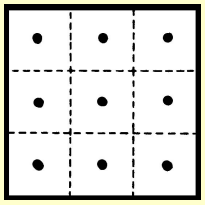
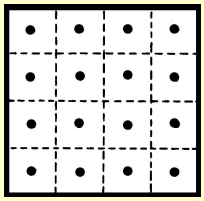
1 per square foot: plants that are thinned or planted 12 inches apart.

4 per square foot: plants that are thinned or planted 6 inches apart.

9 per square foot: plants that are thinned or planted 4 inches apart.

16 per square foot: plants that are thinned or planted 3 inches apart.

IT'S ALL THAT SIMPLE

You can practice getting the correct spacing with your fingers, then try it outside in the garden. Just watch the Introductory Video to see the zip zap finger method followed by the bing-bing, bing-bing movement. It's fun and a great way to get the whole family excited about gardening.

Make Your Own Set of Mel's Planting Guides

Some people cut out planting guides from 12" x 12" squares of cardboard. See our "What's New" – "Teaching Aids" page for details of construction. For use indoors or in teaching, make a set with the holes marked with a magic marker. For actual use outdoors, cut or drill the holes out with a 1 inch diameter hole saw. Then lay the cards down between the grids, poke the holes, and place a pinch of seeds into each hole. Then pick up the planting guide so they don't get wet. That way your set of guides will last for many seasons. Some people also like to write on each guide which flowers, vegetables, or herbs use that particular spacing

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Plant Spacings for Square Foot Gardens

In the following list, all spacings are according to Mel in SFG (chapter 18) unless otherwise indicated (Mel left a few out!)

Basil	1/sqft
Beans: bush (French)	9/sqft
Beans: pole (Runner)	8/sqft
Beets	16/sqft
Broccoli	1/sqft
Cabbage	1/sqft
Carrots	16/sqft
Cauliflower	1/sqft
Celery	4/sqft (6")
Chard(Swiss)	4/sqft
Corn	1/sqft
Cucumbers	2/sqft in a row of 4 sqft (6" apart along middle of sqft row)
Daffodils	36/sqft
Eggplant	1/sqft
Garlic	4/sqft (6") Some say 9/sqft (4")
Leeks	9/sqft (see special technique in 2/96 OG)
Lettuce	4/sqft
Marjoram	4/sqft (according to sqft reader Kevin M. Wilson)
Muskmelons	1/sqft (grow in row of 4 squares, on trellis)
Okra	1-2/sqft
Onions	16/sqft
Oregano	1/4sqft
Parsley	4/sqft
Peas	8/sqft
Peppers	1/sqft
Potatoes	1/sqft
Radishes	16/sqft
Savory	1/sqft
Scallions	36/sqft (2")
Spinach	9/sqft
Squash	Summer: vine-type 3/4sqft (see special grid); bush-type 1/3sqft Winter: 1/2sqft (see special grid)
Thyme	4/sqft

Tomatoes	bush-type: 4/4sqft (see special grid); vine-type 1/sqft (in row of 4 on trellis)
Watermelon	bush-type 1/sqft; vine-type 1/2sqft - both kinds along trellis
Zucchini	1/sqft

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Gardening in Containers

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Container Gardening

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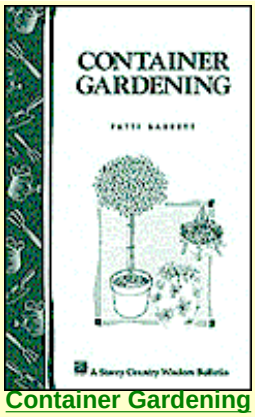
Even the smallest patio or porch can boast a crop of vegetables or a garden of flowers in containers. Planter boxes, wooden barrels, hanging baskets and large flowerpots are just some of the containers that can be used. The container gardener is limited only by his imagination. Consider the following guidelines when choosing your container.

- Avoid containers with narrow openings.
- Cheap plastic pots may deteriorate in UV sunlight and terracotta pots dry out rapidly. Glazed ceramic pots are excellent choices but require several drainage holes.
- Wooden containers are susceptible to rot. Redwood and cedar are relatively rot resistant and can be used without staining or painting. Avoid wood treated with creosote, penta or other toxic compounds since the vapors can damage the plants. One advantage of wooden containers is that they can be built to sizes and shapes that suit the location.
- Use containers between 15 and 120 quarts capacity. Small pots restrict the root area and dry out very quickly. The size and number of plants to be grown will determine the size of the container used. Deep rooted vegetables require deep pots.
- Make sure your pot has adequate drainage. Holes should be 1/2 inch across. Line the base of the pot with newspaper to prevent soil loss.
- In hot climates use light-colored containers to lessen heat absorption and discourage uneven root growth.
- Set containers on bricks or blocks to allow free drainage.
- Line hanging baskets with sphagnum moss for water retention. Keep baskets away from afternoon sun.
- If you choose clay pots, remember that clay is porous and water is lost from the sides of the container. Plants in clay pots should be monitored closely for loss of moisture.



Container Gardening

This 32-page booklet is part of Storey Publishing's Country Wisdom series. In this informative booklet you'll learn:

- How to select containers
- How to choose a good potting mix or make your own.
- How to plant and care for your container gardens.
- How to create beautiful hanging baskets and windowboxes.
- Which plants are best for containers.
- And more!

Growing Mixture

Bulbs for Fall Planting

- Tulips
- Daffodils
- Hyacinths
- Crocus
- Specialty Bulbs
- Amaryllis
- Alliums

Bulk Seeds for Fall Planting

Black-Eyed Susans

California Poppy Seeds
25% Off

Coreopsis Seeds

Blanket Flower Seeds

Blue Lupine Seeds

Prairie Coneflower

White Yarrow

Make sure your planting medium drains rapidly but retains enough moisture to keep the roots evenly moist. Your **compost** will make an excellent potting soil. Check the requirements of the plants you grow to determine whether you will need to add sand. If compost is not available, purchase a good quality potting mixture or make your own from equal parts of sand, loamy garden soil, and peat moss. Commercial potting mixes are usually slightly acidic, so you may want to add a little lime.

Most container gardeners have found that a "soilless" potting mix works best. In addition to draining quickly, "soilless" mixes are lightweight and free from soil- borne diseases and weed seeds. These mixes can be purchased from garden centers.

When you add your soil to your container, leave a 2 inch space between the top of the soil and the top of the container. You will be able to add 1/2 inch or so of mulch later.

Sunlight

Your container garden will need at least five hours of direct sunlight each day, and many plants will benefit from even more. As a general rule, leafy vegetables such as cabbage and lettuce can tolerate the most shade, while root crops such as beets and carrots will need more sun. Fruiting vegetables such as tomatoes and cucumbers need the most sun. The amount of sunlight needed by flowers varies depending on the varieties grown. Check the **flower guides** for sunlight requirements.

Fertilizer

Since potting mixes drain water rapidly, fertilizer will be washed out of the container as you water. Lighter mixes will require more frequent fertilizing than heavier mixes. It's a good idea to use a dilute liquid fertilizer with every other watering. Liquid fish emulsion or liquid seaweed are great plant boosters, but remember that you need to provide your plants with a variety of nutrients. Check the labels on the products in you garden center to be sure that they contain a complete, balanced solution that includes trace elements.

Watering

In an exposed location, container plants loose moisture quickly. Some plants will need to be watered daily, especially during hot, dry weather.

What to Grow?

Annuals

Annuals suitable for containers include:

- **Alyssum**
- **Begonia (Wax)**
- **Browallia**
- **Coleus**
- **Cuphea**
- **Geraniums**
- **Impatiens**
- **Latana**
- **Lobelia**
- **Marigolds**
- **Periwinkle**
- **Nasturtiums**
- **Pansies**
- **Petunias**
- **Salvia**
- **Sanvitalia**
- **Snapdragons**
- **Thunbergia**
- **Verbena**
- **Zinnias**

For more information on creating flower gardens in containers see:

- **Creating a Colorful Container Garden**
- **Heavenly Hanging Hummer Baskets**
- **Eight Rules for Creative Container Garden**

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Container Gardening

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Vegetables

Small salad green such as oak leaf lettuce and mustard cress, or vegetables such as silver beet, which have a quick maturing period are ideal. You may be able to get several crops of a quick maturing vegetable from your container. Cherry tomatoes and other fruiting vegetables, including peppers or eggplant can be easily grown in containers, as can root vegetables such as baby carrots, radishes or spring onions. Try planting quick-growing small herbs and leaf lettuces around you larger fruiting vegetables.

The Edible Container Garden

With *The Edible Container Garden* as your guide, everything from salad greens and savory herbs to luscious fruits and vegetables can be as close as your patio, balcony, or rooftop.

VEGETABLE	TYPE OF CONTAINER	RECOMMENDED VARIETIES
Beans, Snap	5 gal. Windowbox	Bush types such as blue lake, contender, and montpellier
Beans, Lima	5 gal. Windowbox	White Dixie Wonder
Beets	5 gal. Windowbox	Early Wonder, Detroit Dark Red
Broccoli	1 plant/5 gal. pot 3 plants/15 gal. tub	Super Blend, Italian Green Sprouting
Brussels Sprouts	1 plant/5 gal. pot 2 plants/15 gal. tub	Evesham
Cabbage	1 plant/5 gal. pot 3 plants/15 gal. tub	Discovery
Chinese Cabbage	1 plant/5 gal. pot 3 plants/15 gal. tub	Michihli
Carrot	5 gal. Windowbox at least 12" deep	Short & Sweet, Danvers Half Long, Tiny Sweet, Baby Finger Nantes, Goldenhart, Little Finger, Royal or Red Cored Chantenay, Ox Hart, Baby Finger

Bulbs for Fall Planting

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- Daffodils
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Blue Lupine Seeds

Prairie Coneflower

Cucumber	1 plant/gal. pot	Patio Pik, Spacemaster, Pot Luck, Bush Whopper, Bush Champion, Burpee Hybrid, Salad Bush, Parks Burpless Bush, Burpless Early Pik
Eggplant	3 gal. pot	Slim Jim, Ichiban, Black Beauty, Modern Midget, Mission Bell, Small Ruffled Red, Thai Green, Bambino
Garlic	8-inch deep container	Most Varieties
Lettuce	5 gal. Windowbox	Salad Bowl, Ruby, Grand Rapids, Oak Leaf, Buttercrunch, Dark Green Boston, Little Gem, Bibb
Onion	5 gal. Windowbox	White Sweet Spanish, Yellow Sweet Spanish
Pepper	1 plant/2 gal. pot 5 plants/15 gal. tub	Sweet Banana, Yolo Wonder, Long Red Cayenne, Bell Boy, Keystone Resistant, California Wonder, New Ace, Red Cherry, Long Red Cayenne, Jalapeno, Thai Hot
Radish	5 gal. Windowbox	Cherry Belle, Icicle, Champion, Scarlet Globe
Spinach	5 gal. Windowbox	Dark Green Bloomsdale, Melody, America, Avon Hybrid
Squash	2 gal. pot	Scallopini, Baby Crookneck, Creamy, Golden Nugget, Gold Rush, Zucchini (most varieties)
Tomatoes	Bushel baskets 5 gal. pots	Tiny Tim, Small Fry, Sweet 100, Patio, Burpee's Pixie, Toy Boy, Early Girl, Better Boy VFN, Pixie, Red Robin, Sugar Lump, Tumblin' Tom (hanging baskets)

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Urban Agriculture Notes

Published by City Farmer, Canada's Office of Urban Agriculture

The Green Roof Monitor

Please go to the **Green Roof Infrastructure Monitor** web site where all issues are now published in PDF format.

THE GREEN ROOF INFRASTRUCTURE MONITOR - Vol. 2, No. 2, Summer 2000

Welcome to Vol. 2, No. 2 of the Green Roof Infrastructure Monitor, a quarterly report on current and emerging green roof events and opportunities.

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GREEN ROOFS FOR HEALTHY CITIES NEWS

About Green Roof Infrastructure & Our Business Coalition

Green roof infrastructure provides a wide range of public and private benefits. These extend from improved stormwater management and smog reduction to energy efficiency, cost savings and new amenity space for building occupants. Green Roofs

for Healthy Cities is a business coalition founded in March 1999 to foster the development of a market for green roof infrastructure. Green roof development involves the creation of 'contained' green space on top of a human-made structure. This green space can be below, at, or above grade, but in all cases the plants are not planted in the 'ground'. A green roof is an extension of the existing roof, which involves a special root repelling membrane, a drainage system, a lightweight growing medium and plants. The members of the Coalition are Kaaren Pearce, De Boer Environmental Concepts; Doug Flynn and John McManus, Flynn Canada Ltd.; William Bean and Brian Lambert, Garland Canada; Al Duwyn, IRC Buildings Sciences Group Inc.; Bill Stensson and Manuel Sobrinho, Sheridan Nurseries; and George Challies and Colin Donaldson, Soprema Inc. Please visit our website at: www.peck.ca/grhcc/main.htm for information about these firms and e-mail Steven Peck, Executive Director, Green Roofs for Healthy Cities at speck@peck.ca for membership information.

Toronto Green Roof Demonstration Projects - Implementation Has Begun
Green Roofs for Healthy Cities' members and City of Toronto staff are moving forward with the implementation of both sites of the Green Roof Infrastructure Demonstration Project: the Eastview Neighbourhood Community Centre and a portion of the Podium Roof at Toronto City Hall. This summer, City Council approved bringing $165,000 from the 2004 Capital Works budget in support of the project and the Toronto Atmospheric Fund also approved $30,000 in funding. The members of Green Roofs for Healthy Cities have contributed over $100,000 in materials and labour towards the project. We are awaiting the final decision on funding from the Federal Government's Technology for Early Action Measures program which will allow the National Research Council's Institute for Research in Construction and Environment Canada to conduct much needed detailed site and aggregate technical research on green roof benefits.

The planting of the 7,000 square foot extensive green roof at Eastview will be conducted in the Spring of 2001 in order to maximize plant survivability and facilitate the implementation of monitoring equipment. The Podium Roof at City Hall will be completed this fall. The Podium green roof will include eight separate plots which demonstrate a range of intensive, semi-intensive and extensive green roof applications. itate the sharing of information among green roof researchers and profile new and ongoing research projects. Lnks to current and planned green roof infrastructure projects and contact information for green roof researchers in North America is currently online. The second addition is our City of Toronto Demonstration Project Updates. This information will be online October 15, 2000 and will include detailed project descriptions and photos of the two green roof demonstration sites in the City of Toronto: the Eastview Neighbourhood Community Centre and the Podium Roof at Toronto City Hall. The project updates will include information such as site location, technical specifications, proposed research and research findings. If you would like to make changes to your research project description or contact information, or submit information about a new green roof research project, please contact Stephanie Tencer, tel: (416) 971-4484 or email:

stencer@peck.ca.

LOCAL NEWS

City of Toronto Endorses Green Roofs in Planning Report
Toronto at the Crossroads: Shaping Our Future sets out the directions for the new Official Plan. It is the result of over a year of consultations and contains descriptions of five proposed campaigns that are designed to unite vision, policy and action. Under the Campaign to Green Toronto the report states, "One of the greatest opportunities for greening the City is the promotion of 'green roofs' which involves layering contained soil and planting gardens on the flat roofs dominating the landscape of many districts in Toronto. Green roofs do much more than improve the view from downtown skyscrapers. They also: absorb stormwater and reduce off-site flows; absorb carbon dioxide and work against the greenhouse effect; conserve energy for the building below them; and, can be made into beautiful flower gardens or bountiful food gardens for occupants. The City is leading by example by creating green roofs on civic buildings. We also need to encourage the construction of green roofs in new flat-topped buildings undergoing development review." To download Toronto at the Crossroads: Shaping Our Future in PDF file format, visit: www.city.toronto.on.ca/torontoplan/crossroads_change.htm.

Toronto Atmospheric Fund and Public Health Plan Heat Island Conference
In order to develop strategies to reduce health risk from severe summer heat, the Toronto Atmospheric Fund and Toronto Public Health have obtained funding from Natural Resources Canada and the Climate Change Action Fund to hold a major conference on this subject in Toronto in the Fall of 2001. The $122,000 grant includes funding to conduct research on heat and health issues in Toronto and to develop long term adaptation strategies. Green roofs hold significant potential as an adaptation strategy for reducing the urban heat island effect. For more information please contact Phil Jessup, (416) 392 0253 or email: taf@city.toronto.on.ca.

New Condo Green Roof Installed in Toronto
High atop the 12th floor rooftop of the former Sears building a garden is growing. The newly renovated Merchandise lofts needed a green space and there was nowhere to go but up. Landscape designer Terry McGlade's plan includes a 150' prairie meadow of perennials and a wetland garden with walkways and decking areas leading throughout. McGlade's company Perennial Gardens has planted over 8,000 plants of 45 different varieties, including roses, native grasses, dogwoods, and birch trees. Working with Soprema's 'Sopraflor' as the growing medium and installing an in-ground irrigation system ensured a hospitable environment on an otherwise windy and barren area. This is the first large scale 'Greenroof' designed specifically for a condo development in Canada. Residents will be able to enjoy the view of the lake and Toronto skyline while swimming and sunning in one of the city's most exclusive and unusual gardens.

Seneca College Research Update
Seneca College has partnered with the Toronto and Region Conservation Authority,

York University, Greenland International and Sustainable Development and Monitoring Inc. to develop a 'comprehensive' green roof system. This system will include a planted rooftop garden, a rooftop greenhouse, a rooftop catchment area, a rooftop control area, and an internal living wall system. The expected benefits from this system, which will be monitored include: runoff volume reduction, improved water quality, increased energy efficiency and improved indoor and outdoor air quality. Initial funding for the project has been secured and preliminary design is currently underway. It is proposed to implement this system at Seneca College as a component of the SuperBuild renovations which are currently being developed. Construction is scheduled for 2001-2003. This green roof system will function as a living lab for research and educational purposes. For more information, contact Christine Doody-Hamilton at Seneca College (416) 491-5050.

INTERNATIONAL NEWS

Update on Chicago City Hall Green Roof Demonstration
On September 19th, the City of Chicago will begin planting on top of their City Hall building. The 38,000 square foot green roof demonstration project will include a range of intensive and extensive green roof applications with soils as much as 18 inches deep in some locations. Over 20,000 herbaceous plants will be planted and technical research conducted on air quality, water, and biodiversity benefits. For more detailed information please visit the Researchers' Corner on the Green Roofs for Healthy Cities web site: www.peck.ca/grhcc/main.htm.

Chicago Funds Green Roofs to Reduce the Urban Heat Island
The City of Chicago Department of Environment will be issuing green roof grants under its 1999 Urban Heat Island Reduction Initiative. The mission of the Initiative is to utilize, develop and expand upon 'green' technologies that will mitigate the urban heat island effect, beautify Chicago and educate the public. The goal of the program is to provide an opportunity for Chicagoans to reduce urban air temperatures, lower electricity usage, reduce air pollution, and increase green space. Specifically, the initiative will include projects such as installing green roofs, painting or installing light coloured roofs and breaking up asphalt parking lots through the use of plants and alternative planting. For more information about grant eligibility, please visit: w4.ci.chi.il.us./env/AirToxPollution/UrbanIslands.html or contact: John Beaudry, (312) 744 5917.

Portland 'EcoRoof' Reaches First Year of Maturity
The Hamilton Apartment Building 'ecoroof' in Portland, Oregon has reached its first year of maturity and has weathered Portland's dry summer months successfully. The ecoroof has been irrigated to assure vegetation establishment during the first year. Garland Company, Housing Authority of Portland, and City of Portland Bureau of Environmental Services representatives met recently to address any issues pertaining to the ecoroof. A few minor corrections were identified and the Garland Company is once again responding in a timely and professional manner. The city has installed flow metres and a rain gauge to measure stormwater flows and precipitation. The ecoroof has been visited by hundreds of people: architects, landscape architects,

developers, city officials, and out-of-state and international guests. Almost everyone enjoys the beauty and appreciates the functions the green roofscape has to offer. At least four other projects are currently being designed, including a 20,000 square foot portion of the Oregon Convention Center expansion. For more information, contact Tom Liptan at: toml@bes.ci.portland.or.us.

OPPORTUNITIES & EVENTS

Singapore Delegation Coming - October 16-17
On October 16th and 17th, the City of Toronto will be hosting a delegation of senior officials from the Government of Singapore. The officials are coming to Toronto for two days to learn about the City's efforts to implement green roof infrastructure. They will be visiting several sites and meeting with City officials and representatives of Green Roofs for Healthy Cities, the University of Toronto and the Rooftop Gardens Resource Group. For more information, please contact Sean Cosgrove, tel: (416) 392-1107 email: scosgrov@city.toronto.on.ca.

Toronto Green Roof Demonstration Launch Planned for Late October
A launch is being planned for the Toronto Green Roof Demonstration Projects for late October at the City of Toronto. Details will be available online in late September.

This issue of the Green Roof Infrastructure Monitor was prepared by Steven Peck and Stephanie Tencer with contributions from John Beaudry, City of Chicago; Christine Doody-Hamilton, Seneca College; Tom Liptan, City of Portland; and, Candy Venning, Perennial Gardens. Please forward green roof industry developments to the attention of Stephanie Tencer, stencer@peck.ca. Green Roofs for Healthy Cities is organized and administered by the Cardinal Group Inc.

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Please visit our electronic journal on urban sustainability, the New Urban Agenda, Green Roofs for Healthy Cities and other free information products on our web site!

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Green Roof Presentation In Ottawa - April 14 - Noon!

COALITION NEWS

About Green Roof Infrastructure and our Business Coalition Green roof infrastructure provides a wide range of public and private benefits. These extend from improved stormwater management and smog reduction to energy efficiency, cost savings and new amenity space for building occupants. Green Roofs for Healthy Cities is a business coalition founded in March 1999 to foster the development of a market for green roof infrastructure. Green roof development involves the creation of 'contained' green space on top of a human-made structure. This green space can be below, at, or above grade, but in all cases the plants are not planted in the 'ground'. A green roof is an extension of the existing roof, which involves a special root repelling membrane, a drainage system, a lightweight growing medium and plants. The Members of the Coalition are Doug Flynn and John McManus, Flynn Canada Ltd.; William Bean and Brian Lambert, Garland Canada; Al Duwyn, IRC Buildings Sciences Group Inc.; Kaaren Pearce, De Boer Landscape & Maintenance; Bill Stensson and Manuel Sobrinho, Sheridan Nurseries; and Colin Donaldson, Soprema Inc. Please visit our website at www.peck.ca or e-mail Steven Peck, Executive Director, Green Roofs for Healthy Cities at speck@peck.ca for membership information.

LOCAL NEWS

Toronto's Environmental Task Force Recommends Green Roof Demonstration Project and Assessment of Benefits for City In February, the City of Toronto's Environmental Task Force (ETF) completed its proposed Environmental Plan, which is scheduled to be presented to City Council for approval on April 10, 11 and 12, 2000. The Plan, entitled Clean, Green and Healthy: A Plan for an Environmentally Sustainable Toronto, contains recommendations about goals, targets, policies, strategies, structures and processes that will lead Toronto in the direction of environmental sustainability. Among the 63 recommendations is a recommendation that the City report to Council and a proposed Sustainability Roundtable before the

end of 2000 on a strategy to encourage green roofs and rooftop gardens. More specifically, the Plan recommends that the strategy should:

a) address the potential for retrofitting green roofs and rooftop gardens on City-owned buildings;
b) address how green roofs and rooftop gardens can be implemented in new developments; and
c) address the environmental benefits that can be derived from green roofs and rooftop gardens (e.g., CO2 reduction, stormwater retention, microclimate improvements, etc.).

In addition, the ETF has recommended that City Council establish an Investment/Reserve Fund to be used to begin implementing the recommendations. Among the list of priority recommendations is the encouragement of green roofs. It is recommended that $30,000 be allocated for a strategy team to analyze the benefits of green roofs in the City and $250,000 be allocated for a City Hall demonstration project. It is also recommended that the Toronto Atmospheric Fund be approached as a possible funding partner for this initiative.

For more information about the ETF and the Environmental Plan, please call (416) 392-3819 or e-mail: etf@city.toronto.on.ca

Toronto Green Roof Feasibility Study -Completed by Steering Committee In June of 1999, Toronto's Adminstrative Services Committee approved of a green roof demonstration project at City Hall in principle, and asked Green Roofs for Healthy Cities to work with Facilities and Real Estate to develop a feasibility study. An interdepartmental committee (see below) has recently completed the study, which recommends proceeding with two demonstration sites, one located on a 6,000 square foot portion of the Podium roof at City Hall and a second site located at the Eastview Neighbourhood Community Centre which is scheduled for re-roofing this year. Highlights of each site are presented below.

Eastview Neighbourhood Community Centre
The Eastview Neighbourhood Community Centre demonstration site is located over a gym and is approximately 5,000 square feet in size. The roof at this site is considered to be typical of a large number of buildings in the Toronto area, with a minimum loading capacity. The demonstration green roof will be inaccessible and extensive. Green Roofs for Healthy Cities, in partnership with the National Research Council and Environment Canada has applied for over $300,000 in funding from the Climate Change Action Fund's Technology for Early Action Measures (TEAM) program. The funds will be used to conduct research at this site, develop an interpretive program and model the urban heat island effect in Toronto. The research, to be undertaken over three years, involves installing sensors and monitoring equipment to study benefits such as improved energy efficiency, stormwater retention and quality improvements and the extension of the roof membrane life span. The feasibility of conducting this research will depend on approval of Federal Government funding and approval from the Adminstrative Services Committee. The cost of the green roof at

Eastview can be accommodated within the City's existing capital budget.

City Hall Demonstration Site
The City Hall demonstration site is approximately 6,000 square feet in size. The proposed green roof would be accessible to the public. The demonstration would likely be in place for five years, since the Steering Committee has recommended that the entire podium roof be considered as part of the upcoming design competition for City Hall. The site has multiple benefits and would serve as an excellent 'on the ground' educational infrastructure. It will help potential green roof clients and industry representatives to improve their understanding about green roof infrastructure technology. A variety of applications at different soil depths and plants communities have been planned. The University of Toronto is also interested in conducting research on water quality and native plant ecology at the site.

The green roof could also provide valuable amenity space for the occupants of City Hall, surrounding buildings, and the general public. The project will involve replacing a section of the aging roofing system near the flag pole. The entire roof is scheduled to be replaced in 2004. The cost of re-roofing this section of the City Hall roof is $165,000 and the cost of the green roof demonstration portion is $120,000. Before this project can proceed, additional funding will be required. The full Steering Committee report is scheduled to go before Administrative Services Committee on April 25, 2000.

Feasibility Project Steering Committee Members
The Phase I Green Roof Infrastructure Demonstration Project Steering Committee involved a wide number of representatives from different City departments and agencies. The staff and members of Green Roofs for Healthy Cities would like to publicly thank all those who contributed their time to the preparation of this report: Jim Kamstra, Facilities & Real Estate (Co-chair); Alka Lukatela, Urban Design; Arthur Beauregard and David O'hara, Parks & Recreation; Bas Baskaran, Karen Liu and William Lei, National Research Council, Institute for Research in Construction; Bill Macdonald and Pamela Georgopolous, Works & Emergency Services; Brad Bass and Monirul Q. Mirza, Environment Canada, Adaptation & Impacts Research Group; David Stonehouse, Urban Planning & Development Services; George Padanyi and Jamie McFadyen, Facilities & Real Estate; Lisa Salsberg, Healthy Cities Office; Lois Corbett, Toronto Environmental Alliance; Lorne Cappe and Richard Stromberg, Heritage Toronto; Michael McClelland, ERA Architecture; Monica Campbell, Toronto Public Health; Monica Kuhn, Rooftop Garden Resource Group; Monica Tang, Councillor Layton's Office; Richard Morris, Lai Wong, Christine Merhej and Stephanie Salbach, Energy Efficiency Office and Sandra Rodriguez, Strategic and Corporate Policy, CAO's Office;

European Green Roof Industry Research at Ryerson University
Green Roofs for Healthy Cities is currently overseeing a research effort with a group of senior Urban and Regional Planning students at Ryerson Polytechnic University. The goal of the research project is to collect information on the development and status of a green roof industry in different European and Oceanic countries. The group

is also assembling an annotated archive of information pertaining to the benefits and barriers of urban food production on green roofs. For more information, please contact Dr. Joe Springer, Professor, School of Urban & Regional Planning, (416) 979-5000, ext. 6766.

York University to Implement Green Roof for New Computer Building
Soprema Inc.'s Sopranature green roof system will be installed on the roof of the new Computer Science Building at York University. Flat roofs on different levels will be greened as well as a sloped roof of 10 degrees. Included in the design is a wildflower meadow. The green roofs will mainly be inaccessible. The green roofs were designed by Busby and Associates and Architects Alliance from Toronto. York University decided to include a green roof and use Soprema Inc.'s system for a number of environmental reasons, the primary one being the high stormwater retention capacity of Soprema's system. This will help to reduce the evacuation of stormwater, some of which is being stored in basins on the roof. For more information, please contact Marie-Anne Boivin at: maboivin@sopremacanada.com

NATIONAL NEWS

Green Roof Planned for Edmonton Mall
This spring, Soprema Inc.'s Sopranature system will be used for a garden on the Concourse Courtyard of the Telus Plaza in Edmonton. Architectural and landscaping drawings were done by the Edmonton-based firm, Stantec Architects. The terrace is designed with rectangular sections of low ground cover between spaces of pavers for pedestrians. The centre of the terrace focuses on a big tree and an elevated amount of soil that is also covered by ground cover. IRC Building Sciences Group Inc. Establishes a National Presence IRC Building Sciences Group Inc. is pleased to announce the opening of a new office in Calgary, Alberta adding to current office locations in Mississauga, Ottawa and London, Ontario. In an effort to provide a truly cross Canada presence for their national clients, IRC Group has undertaken this new expansion to continue to improve the level of services to existing clients as well as the development of new clients throughout Western Canada.

IRC Building Sciences Group Inc. is an unbiased and independent professional consulting firm specializing in building science engineering, focusing predominantly on building performance, evaluation and rehabilitation of commercial, institutional, industrial and residential facilities. For more information, please call Zen Szewczyk, Director of Marketing & Sales at: (905) 607-7244 or toll free at: 1 (888) 607-5245, or by e-mail: zszewczyk@ircgroup.com

Greenbacks from Green Roofs Report - Now On-line in PDF Format A report prepared for Canada Mortgage & Housing Corporation on the barriers and opportunities related to expanding the market for green roofs entitled, Greenbacks from Green Roofs: Forging a New Industry in Canada is now available on-line as a pdf document at: www.peck.ca. Acrobat Reader is required to view the document. To request a hard copy of the report, please contact the Canadian Housing Information Centre by telephone 1 (800) 668-2642 or by e-mail: chic@cmhc-schl.gc.ca

INTERNATIONAL NEWS

City of Chicago Implements $1 Million Green Roof Demonstration In an effort to explore different ways to reduce the urban heat island effect, the City of Chicago will begin construction of a $1 million green roof demonstration and laboratory on top of its' City Hall building. The purpose of the demonstration project is to demonstrate the air quality benefits of green roofs as well as showcase other benefits such as energy efficiency and improved stormwater management. The City expects to save $4,000 a year from reduced heating and cooling costs. This results from the insulative and cooling properties of the green roof. The roof will allow research to be conducted on the suitability of different plants, specifically species native to the Chicago 'rooftop' climate.

The City will also be working with the Lawrence Berkeley National Laboratory to better understand the potential of green roofs in improving air quality by reducing the urban heat island effect - the unnatural overheating of the city. Higher city temperatures in the summer contribute to greater air pollution in the form of smog and particulate matter. Higher temperatures also require the use of more energy for cooling buildings. "There are lots of practical and simple techniques for reducing urban heat islands. Green roofs have the added advantage of making the surroundings more attractive," said William Abolt, Commissioner of Environment for the City of Chicago.

The Chicago City Hall green roof demonstration project will showcase 3 different soil depths and a variety of plants, including oak trees. The design will green more than 50% of the total City Hall roof and incorporates pathways for maintenance and monitoring. Green roofing is scheduled to begin in April 2000. Planting is expected to take place during late spring or early summer. For more information on the City Hall project, please contact John Beaudry at: jbeaudry@CI.CHI.IL.US

Philadelphia Holds First Urban Agriculture Conference in North America
On March 6, 2000, the Pennsylvania Horticulture Society held a conference on urban agriculture in Philadelphia. Conference participants explored avenues to improve the economic viability of significantly increasing urban food production. Lauren Baker, Urban Agriculture Coordinator from Toronto's Food Share presented on the Annex Organics' green roof food production system. In a related development, Toronto's Food Policy Council has released a discussion paper entitled, Feeding the City From the Back Forty, which includes recommendations on piloting different urban agriculture projects including green roof food production projects. For copies of the report, contact Sean Cosgrove at: tfpc@city.toronto.on.ca

Outstanding Growth of the German Green Roof Infrastructure Industry
With direct financial investment and regulations requiring green roofs by over seventy local governments, the market for green roof infrastructure in Germany has grown by an average of 10-15% annually over the past decade. In 1999, there were 50 million square metres of green roof infrastructure installed in Germany. This number represents over 10% of the flat roofed buildings in Germany.

Australia's City of Port Phillip Conducts Study on Green Roof Benefits
Since 1998, the City of Port Phillip has been researching the practical benefits of vegetating urban walls and roofs with funding provided by the State government under an urban design grant. The study, which should be completed in 2000, involves three universities - Monash, Melbourne and Deakin. Various greening strategies will be assessed for their relevance to five broad project objectives: improving indoor and outdoor comfort levels for residents; reducing energy demand for heating and cooling; reducing the quantity and increasing the quality of stormwater run-off; conserving indigenous biodiversity (genetic, species and ecoystems); and encouraging environmentally responsive design strategies in the City. For more information please contact: Terry White, Project Coordinator: terryw@vicnet.net.au.

OPPORTUNITIES & EVENTS

Green Roof Presentation In Ottawa - April 14 - Noon!

On Friday April 14, 2000, Steven Peck, Executive Director of Green Roofs for Healthy Cities will give a public presentation entitled, "Green Roofs: Sustainable Development Infrastructure for the 21st Century" at Canada Mortgage and Housing Corporation, 700 Montreal Road, Ottawa. Room C1-101 From 12:15 to 1:30.

The presentation will provide an overview of the many public and private benefits of green roof infrastructure - an excellent example of a sustainable development technology. Mr. Peck will also provide participants with an update on the current and planned activities of Green Roofs for Healthy Cities.

The Green Roof Infrastructure Monitor was prepared by Steven Peck and Stephanie Tencer with contributions from: Lauren Baker, Field to Table; Marie-Anne Boivin, Soprema Inc.; Sean Cosgrove, Toronto Food Policy Council and Zen Szewczyk, IRC Building Sciences Group Inc.

Stephanie Tencer, Associate, Peck & Associates
"economic solutions for sustainability"
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277 Wellington Street West, Suite 701, M5V 3E4 www.peck.ca
Please visit our electronic journal on urban sustainability, the New Urban Agenda, Green Roofs for Healthy Cities and other free information products on our web site!

Vol. 1, No. 1 Summer 1999

Welcome to the inaugural issue of the Green Roof Monitor, a quarterly report on current and emerging green roof

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ABOUT GREEN ROOFS AND OUR BUSINESS COALITION

Green roofs provide a wide range of public and private benefits. These range from improved stormwater management and smog reduction to better energy efficiency and new amenity space for building occupants. Green Roofs for Healthy Cities is a business coalition founded in March, 1999 to foster the development of a market for green roof products and services. Green roof development involves the creation of 'contained' green space on top of a human-made structure. This green space can be below, at, or above grade, but in all cases the plants are not planted in the 'ground'. A green roof is an extension of the existing roof, which involves a special root repelling membrane, a drainage system, a lightweight growing medium and plants. The Founding Members of the Coalition are Doug Flynn, Flynn Canada Ltd.; William Bean and Brian Lambert, Garland Canada; Al Duwyn, IRC Buildings Sciences Group Inc.; Frank Baxter, Semple-Gooder Roofing; and Colin Donaldson, Soprema Inc. Please visit our website at www.peck.ca or e-mail Steven Peck, Director, Green Roofs for Healthy Cities at speck@peck.ca for more information.

GREEN ROOFS FOR HEALTHY CITIES COALITION LAUNCH EVENT

On June 14th, Green Roofs for Healthy Cities hosted a wine and cheese event to formally launch the Coalition. Held at Toronto City Hall, attendees enjoyed the view of a demonstration green roof from the windows of the Members Lounge while learning about the benefits of green roofs and the products and services offered by Coalition members. The event was well attended by councillors, staff and other interested professionals, and generated significant media attention. Special thanks go to Councillor Brad Duguid, Ward 15, City of Toronto for sponsoring the event.

LOCAL NEWS:

ROOF GREENING AT TORONTO CITY HALL

Efforts are currently underway to generate financial support for a permanent green roof demonstration at Toronto City Hall. Beginning June 9th, Green Roofs for

Healthy Cities initiated a one-week green roof demonstration project. The demonstration green roof was 20 by 20 feet in size and highly visible from the Members' Lounge. Soprema and Perennial Gardens Corporation supplied the necessary materials and facilitated the installation.

THE TORONTO HOUSING COMPANY BEING ENCOURAGED TO INVESTIGATE OPPORTUNITIES FOR GREEN ROOFS

On February 23rd,1999, the Strategic Policies and Priorities Committee, chaired by Mayor Mel Lastman, recommended that the Board of Directors of the Toronto Housing Company consider preparing a report that investigates the opportunities to establish rooftop and on-site community gardens on residential buildings owned by the Toronto Housing Company, with estimates of costs and possible sources of funding. For more information, contact Monica Tang at (416) 392-4058.

CHANGES RECOMMENDED TO TORONTO'S GREEN PROCUREMENT POLICY

On June 1st, Green Roofs for Healthy Cities made a deputation to the Strategic Policies and Priorities Committee. The Committee unanimously accepted the following proposed changes to Toronto's green procurement policy:

Given the environmental and economic importance of infrastructure, green procurement principles should be fully applied to construction design, processes, tendering and materials;
Given that many 'green' products and services can produce a variety of tangible benefits, full consideration should be given to the long term and complete costs and benefits of green procurement.
The policy must go to the full Council for final approval. These principles, if adopted by the full Council, will help generate a market for green roofs and other green building technologies.

ADMINISTRATIVE SERVICES COMMITTEE SUPPORTS GREEN ROOF DEMONSTRATION

On June 15th, Green Roofs for Healthy Cities made a deputation to the City of Toronto Administrative Services Committee, chaired by Councillor Lorenzo Beradinetti. The Committee reports having:

- Endorsed, in principle, the concept proposed for a demonstration green roof at Toronto City Hall;
- Requested the Acting Commissioner of Corporate Services to submit a report to the Administration Committee on the concept as proposed and the request for proposal suggested by the Green Roofs for Healthy Cities Coalition;
- Requested the Planning and Transportation Committee to invite representatives of the Green Roofs for Healthy Cities Coalition to make a presentation to the Planning and Transportation Committee on land use planning and other tools that can be considered regarding this project;
- Requested the Toronto Atmospheric Fund to give consideration to providing

funding assistance to the Coalition to help move the project forward.

The Coalition is now working to help implement the recommendations of the Administrative Services Committee.

SEMPLE-GOODER ROOFING GREENS HOSPITAL ROOFS

Semple-Gooder Roofing is working with Mary Jane Lovering of Vertechs Design Inc. to finalize the drawings for the new green roofs at the Trillium Centre in Mississagua, formerly Mississauga Hospital. The design entails installing an intensive green roof system in a highly visible area of the hospital which includes approximately four small roof areas. Two of these areas will have membranes prepared for green roof installation. This project will be completed in approximately three phases and will cover approximately 12,500 square feet of roof area. In addition to aesthetics, energy savings and an extended life span of the roofing membrane, research suggests that having green space in patients' view helps to speed their recovery. For more information, contact Frank Baxter at (416) 743-5370 or Ms. Lovering at (416) 925-6097.

GARLAND INSTALLS CONDO GREEN ROOF IN PORTLAND

Portland Oregon's condominium community is among the first in North America to embrace green roofing. The Garland Company, a manufacturer of waterproofing and green roofing systems, has recently landscaped a condo community's rooftops with plants native to Portland, willowy wildflowers and verdant ground covers. For more information about the ecological, functional and health benefits of this high performance green roof system contact Brian Lambert at blambert@garland.com or call 1-800-321-9336.

SOPREMA INSTALLS A GREEN ROOF FOR A HYDRO-ELECTRIC PROJECT

La Centrale Hydroelectrique des Chutes-de-la-Chaudiere, promoted by Ennergex, is the first project in North America where an extensive green roof has been incorporated into the overall design. Soprema has recently been working to install a green roof with hardy perennials on 8 inches of growing medium, and shrubs on 12 inches. The central building of the electric dam project is covered by an accessible deck for tourists and pedestrians, who can see the waterfalls from near and view the turbines inside the building from the skylights on the roof. For more information, please contact Marie-Anne Boivin, Soprema, at 1-800-463-2382.

CITY OF TORONTO'S GREEN ROOFS IN DISGUISE

There are a number of green roofs in the city of Toronto. Since many are at street level, most people are unaware that they are green roofs. The new Metro Convention Centre Roundhouse Park (street level) Ryerson University athletic complex (street level) Downtown Sheraton Centre (above grade) Mountain Equipment Co-Op (above grade) Nathan Phillips' Square Peace Garden and flower beds (street level) Royal York Hotel (herb garden, above grade) Manulife Centre (amenity space, above grade)

NATIONAL NEWS:

CMHC PUBLISHES REPORT QUANTIFYING THE BENEFITS OF GREEN ROOFS

CMHC has recently published a report prepared by Steven Peck, Peck & Associates, Monica Kuhn, Architect and Dr. Brad Bass, Environment Canada entitled, Greenbacks from Greenroofs: Forging a New Industry in Canada. The report highlights the quantitative and qualitative benefits of green roof and vertical garden technologies, barriers to the widespread adoption of these technologies as well as a proposed national action plan to overcome existing barriers. To obtain a free copy of the report, please contact the Canadian Housing Information Centre at 1-800-668-2642 or e-mail chic@cmhc-schl.gc.ca

INTERNATIONAL NEWS:

CHICAGO GREENS ROOFS TO COOL CITIES

The City of Chicago's Department of Environment plans to implement green roofs on several city buildings over the summer as a way to help cool cities and reduce smog. The planned projects will demonstrate different garden designs, different kinds of plants that can be used and help to work through a variety of construction challenges for different types of roofs. The City will take advantage of opportunities afforded in different parts of Chicago, such as greening roofs along elevated train tracks where passengers can see and enjoy them. The City of Chicago's Department of the Environment is working with the US EPA and the US Department of Energy to measure the ability of these efforts to help cool cities. For more information about the City of Chicago's Rooftop Gardening Initiative, contact Brendan Daley at (312) 742-0150 or b.daley@bi.chi.il.us

'DACH AND WAND' 99 ROOF AND WALL CONFERENCE IN EUROPE

Frank Baxter, vice-president of Semple-Gooder Roofing, recently visited this major industry show in Stuttgart, Germany and reported that approximately 20% of the trade booths featured green roof or vertical garden products and services. This has grown from less than 2% four years ago. As of 1996, over 10 million square metres of green roofs were installed in Germany, and since then the industry has been enjoying a rapid rate of growth.

OPPORTUNITIES AND EVENTS:

Mountain Equipment Co-op

In 1997, Mountain Equipment Co-op contracted Soprema and Heinz Vogt of Stone Kohn McQuire Vogt Architects to design a green roof as part of their ongoing commitment to integrating environmental and economic values. Ed Horner, Assistant Manager of the Co-op, indicated that they get a lot of visitors from the hotel adjacent

to the building, who look down on it and want to learn more about it. The roof covers 60,000 square feet, contains 6 cm of growing material and is home for a variety of grasses, wildflowers and sedum. Although not designed for recreational use, it is possible to arrange a visit to the green roof. For more information contact Anne Lesperance at (416) 340-2667.

TOUR OF GREEN ROOFTOPS

On the morning of Tuesday, September 28, 1999, the Rooftop Gardens Resource Group will co-host a walking tour of various green roofs in downtown Toronto for members of the Coalition, media and other interested parties. The tour will begin at 9:00 A.M. in front of the Peace Garden in Nathan Phillips Square, Toronto City Hall, 100 Queen Street West. Please RSVP with Stephanie Tencer, Coalition Coordinator, Green Roofs for Healthy Cities, 971-4484, or e-mail stencer@peck.ca

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Vol. 1, No. 2, Winter 1999

Welcome to the second issue of the Green Roof Monitor, a quarterly report on current and emerging green roof events and opportunities.

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- Toronto Public Health Identifies Green Roof Infrastructure as Means for Reducing Heat Stress
- Green Economy Workgroup Advocates for Green Roofs
- Green Roofs Identified as Unexplored Potential in Sustainable Energy
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- 77 Cities in Germany Invest in Green Roof Infrastructure
- Chicago Prepares to Green City Hall Roof

COALITION NEWS:

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Green roof infrastructure provides a wide range of public and private benefits. These extend from improved stormwater management and smog reduction to energy efficiency, cost savings and new amenity space for building occupants. Green Roofs for Healthy Cities is a business coalition founded in March 1999 to foster the development of a market for green roof infrastructure. Green roof development involves the creation of 'contained' green space on top of a human-made structure. This green space can be below, at, or above grade, but in all cases the plants are not planted in the 'ground'. A green roof is an extension of the existing roof. It involves a special root repelling membrane, a drainage system, a lightweight growing medium and plants. The Founding Members of the Coalition are Doug Flynn, Flynn Canada Ltd.; William Bean and Brian Lambert, Garland Canada; Al Duwyn, IRC Buildings Sciences Group Inc.; Frank Baxter, Semple-Gooder Roofing; and Colin Donaldson, Soprema Inc. Green Roofs for Healthy Cities is pleased to also welcome Sheridan Nurseries and De Boer Landscape and Maintenance as Coalition members for 2000.

Please visit our website at www.peck.ca or e-mail Steven Peck, Director, Green Roofs for Healthy Cities at speck@peck.ca for membership information. For general information about the Coalition, contact Stephanie Tencer, Coalition Coordinator at stencer@peck.ca.

LOCAL NEWS:

TAF FUNDS ROOF GREENING STUDY FOR TORONTO CITY HALL

The Toronto Atmospheric Fund has granted Green Roofs for Healthy Cities funding in support of Phase I of the Green Roof Infrastructure Demonstration and Monitoring Project. The project involves installing and monitoring the membrane, energy and stormwater benefits of green roofs on 2 city-owned buildings. It has received strong support from a number of City departments, many of which are represented on the Phase I Steering Committee. The Steering Committee is co-chaired by Steven Peck, Peck & Associates and Jim Kamstra, Facilities and Real Estate. Other members include: Bas Baskaran, National Research Council; Brad Bass, Environment Canada; Richard Morris, Office of Energy Efficiency, Works Department; Monica Kuhn, Architect; Pam Georgopolous, Stormwater Management, Works Department; Ted Bowering, Stormwater Management, Works Department; David Stonehouse, Urban Planning and Development Services; Jamie McFadyen, Facilities and Real Estate; Arthur Beauregard, Parks and Recreation; David O'hara, Parks & Recreation; Lisa Salzberg, Healthy Cities Office; Sandra Rodriguez, Strategic & Corporate Policy,

Chief Administrator's Office; Lois Corbett, Toronto Environmental Alliance; Monica Tang, Councillor Layton's Office; Monica Campbell, Toronto Public Health and, Richard Stromberg, Heritage Toronto.

POLICY PROGRESS - CHANGES TO TORONTO'S PROCUREMENT POLICY ACHIEVED

In direct response to Green Roofs for Healthy Cities' lobbying efforts, the City of Toronto has revised their Environmentally Responsible Procurement Policy to include the following provisions:

Given the environmental and economic importance of infrastructure, environmentally responsible procurement principles should be applied to construction design, processes, tendering and materials; and Given that many environmentally preferred products and services can produce a variety of tangible benefits, full consideration should be given to the long-term and complete costs and benefits of environmentally responsible procurement.

These changes should help encourage the adoption of products and services, such as green roof infrastructure, which provide a broader range of social, environmental and economic benefits than are traditionally accounted for.

TORONTO PUBLIC HEALTH IDENTIFIES GREEN ROOF INFRASTRUCTURE AS MEANS FOR REDUCING HEAT STRESS

In July 1999, Toronto Public Health proposed a Hot Weather Response Plan to lessen the impact of hot weather on at-risk populations in Toronto. Within their recommendations, they identify the need to analyze the Toronto heat island effect and explore methods, such as the promotion of green roof infrastructure, to mitigate summer heat over the long term. Toronto Public Health is also proposing a major conference in 2000 to facilitate greater understanding of, and ways of adapting to, extreme weather changes. For more information about the Hot Weather Response Plan, contact Kathleen Harte at (416) 392-1560, extension 87062.

GREEN ECONOMY WORKGROUP ADVOCATES FOR GREEN ROOFS

The Green Economy Workgroup of Toronto's Environmental Task Force submitted The Green Economy Plan and presented some key findings at the Environmental Task Force meeting on October 20, 1999. An integral component of the Plan involves supporting green business sectors through community economic development. The workgroup recommends that "the City should recognize food production as a part of economic and environmental reinvestment, expand community gardening, implement rooftop gardens?". The workgroup also recommends that the City "?develop an action plan to implement a minimum of 10 rooftop gardens on their public properties within the next three years. This action plan should include incentives for green roof design and construction, strategies for linking organic waste recovery with rooftop food production, and supports for research and demonstrations on rooftop food production". For more information about the Green Economy Workgroup, e-mail etf@city.toronto.on.ca or contact Fred Hendriks at (416) 392-3819.

GREEN ROOFS IDENTIFIED AS UNEXPLORED POTENTIAL IN SUSTAINABLE ENERGY PLAN FOR TORONTO

In the Sustainable Energy Workgroup report for Toronto's Environmental Task Force's A Sustainable Energy Plan for Toronto, a number of opportunities for advancing a sustainable energy agenda over the next 5 years in the City of Toronto were identified. Among them is the recognition that, "[t]oronto has huge unexplored potential to achieve reduction in cooling load, improved air quality, reduced noise and improve the City's ambience through plantings of backyard and street trees, rooftop gardens and parking lot trees in neighbourhoods and public spaces". For more information about the Sustainable Energy Workgroup, e-mail etf@city.toronto.on.ca or contact Fred Hendriks at (416) 392-3819.

NATIONAL NEWS:

NRC'S INSTITUTE FOR RESEARCH IN CONSTRUCTION PLANS GREEN ROOF RESEARCH

National Research Council's Institute for Research in Construction held a meeting on November 23rd to invite industry participation in a consortium project to quantify the benefits of green roofs. The project involves the use of two identical buildings in Ottawa, with roof areas of about 1, 000 square feet. One building will be fitted with a generic green roof. For more information, please contact Bas Baskaran, tel: (613) 990-3616, e-mail: bas.baskaran@nrc.ca

INTERNATIONAL NEWS:

GARLAND AND THE PORTLAND GREENSHIELD PROJECT

Garland has installed a green roof on an 8,500 square foot, 10-story, high rise building owned by the Portland Housing Authority. The building, designed by OTAK Architects, uses Garland's high performance StressPly Plus polymer modified membrane, which incorporates the use of post-consumer recycled tires. The Green Roof system installed uses various layers of drainage mats to filter membranes and a specialized soil formulation. The plants growing are primarily low, ground cover seedlings. For more information about this high performance green roof system, contact Brian Lambert at blambert@garland.com or call 1 (800) 321-9336.

77 CITIES IN GERMANY INVEST IN GREEN ROOF INFRASTRUCTURE

Research conducted by Green Roofs for Healthy Cities reveals that in Germany, 10% of all flat roofs have green roofs. This represents over 55 million square metres of green roof infrastructure in place since 1989. Green roof infrastructure is funded through public-private partnerships in Germany. Almost 50 per cent of German cities (77 cities) have programs in place that support the development and growth of a market for green roof infrastructure. 80% of the green roofs are extensive, involving low costs, growing media and plant diversity.

The German Roof Gardeners Coalition has been successfully advocating for green roofs since 1984. For information (in German) about this coalition, their research and lobbying efforts, visit:
http://www.dachgaertnerverband.de/stadt.htm

CHICAGO PREPARES TO GREEN CITY HALL ROOF

The preparations for Chicago's experimental green roof atop City Hall have begun. The 20,000 square foot roof will accommodate 2 oak trees and more than 21,000 plants and shrubs this spring as part of a five-city pilot project assisted by the Environmental Protection Agency and the Department of Energy. In addition to EPA monitoring, infrared satellite photos from the National Aeronautics and Space Administration will be used to measure the program's effectiveness. William F. Abolt, Commissioner of Chicago's Department of the Environment, said he expects the City Hall green roof to result in annual savings of $3,000 to $4,000 due to reduced heating and cooling costs.

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Published by City Farmer
Canada's Office of Urban Agriculture
cityfarm@interchange.ubc.ca

Welcome to Urban Garden

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Resources

Welcome to the Urban Garden. This website was born of my passion for gardening; feeling the soil between my fingers, watching new buds push their way to the light, and sharing a living cocoon of green with birds and bugs and the wind.

Sharing ideas and hints is part of being a gardener. I get as much enjoyment from a gardening book or sharing ideas with my family and friends as in creating a garden environment.

City gardening can be a challenge. There are few resources dedicated to getting the most from the limited spaces of a patio or deck garden. The following pages are my journal of finds and favorites for my Zone 8 container garden.

Enjoy!

Free Screensavers
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Looking for garden catalogs? Stop by the Garden Bazaar!

Container Gardening

This forum is meant for the discussion of gardening in containers.

Instructions on using the forum are provided below.

Related forum: Balcony Gardening

Messages:

- CT overwintering questions
  - Posted by: amysue31 z6 CT on Mon, Aug 30, 04 at 12:13
- Winter safe cement pots?
  - Posted by: beecreature33 z5 NY on Sun, Aug 29, 04 at 19:49
- Winter safe cement pots
  - Posted by: beecreature33 z5 NY on Sun, Aug 29, 04 at 19:34
- giant bird of paradise
  - Posted by: kaerie22 z8 Austin, TX on Sun, Aug 29, 04 at 11:02
- whiskey barrel
  - Posted by: rabbit8 z8a AL on Sat, Aug 28, 04 at 8:05
    - 1 follow-up, posted on Mon, Aug 30, 04 at 15:45
- Good or Bad Pest?
  - Posted by: Ceil57 Pennsylvania on Sun, Aug 29, 04 at 13:09

Your Ad Here!

- 3 follow-ups, last one posted on Mon, Aug 30, 04 at 8:07

- Winter Ideas/Early Spring bulbs?
  - Posted by: LESNYC z6/7 NYC on Sat, Aug 28, 04 at 18:24
    - 1 follow-up, posted on Sun, Aug 29, 04 at 23:46
- Squatters Rights
  - Posted by: nancysil z6 New Engl on Mon, Aug 23, 04 at 20:14
    - 8 follow-ups, last one posted on Sun, Aug 29, 04 at 22:46
- hosta question
  - Posted by: dollladie 5 Indiana on Sun, Aug 29, 04 at 18:54
    - 1 follow-up, posted on Sun, Aug 29, 04 at 21:23
- Impruneta Terra Cotta
  - Posted by: Eric55 5 on Thu, Aug 26, 04 at 23:30
- Fertilizing Toms in E-Boxes
  - Posted by: whizzer75 z7 Al on Mon, Aug 23, 04 at 15:36
- Need help choosing container sizes for veggies
  - Posted by: Castorp z9 FL on Sun, Aug 29, 04 at 9:09
    - 2 follow-ups, last one posted on Sun, Aug 29, 04 at 12:08
- theft!
  - Posted by: kud2poochie z5CHI on Mon, Jun 7, 04 at 20:16
    - 30 follow-ups, last one posted on Sun, Aug 29, 04 at 10:45
- Gladiolas in Containers Done Blooming-Now What?
  - Posted by: PattyinStLouis 5 on Fri, Aug 27, 04 at 13:26
    - 1 follow-up, posted on Sun, Aug 29, 04 at 8:46
- E-Box Problem
  - Posted by: garaj 9B CENTRAL FL on Tue, Aug 17, 04 at 10:54
    - 9 follow-ups, last one posted on Sat, Aug 28, 04 at 14:13
- rice hulls in soil mix
  - Posted by: pigpen_ on Sat, Aug 28, 04 at 3:35

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Calendar of Garden Events

*

Related Listings

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        - 3 follow-ups, last one posted on Sat, Aug 28, 04 at 13:27
- Help to post pics
    - Posted by: shirl36 zone 5 Illinois on Mon, Jul 19, 04 at 16:10
        - 5 follow-ups, last one posted on Sat, Aug 28, 04 at 9:54
- Need Advice .....
    - Posted by: KimAz 9 on Sat, Aug 28, 04 at 0:02
        - 1 follow-up, posted on Sat, Aug 28, 04 at 3:53
- My firsts for Container Gardening
    - Posted by: shirl36 zone 5 Illinois on Sun, Aug 22, 04 at 20:39
        - 9 follow-ups, last one posted on Fri, Aug 27, 04 at 23:15
- Overwintering?
    - Posted by: kdenise z7 GA on Thu, Aug 19, 04 at 17:51
        - 4 follow-ups, last one posted on Fri, Aug 27, 04 at 23:09
- What have you tried to overwinter?
    - Posted by: Gramma_Jan_MN_ZN_4 on Wed, Aug 25, 04 at 2:59
        - 2 follow-ups, last one posted on Fri, Aug 27, 04 at 21:41
- overwinter strawberry in pot
    - Posted by: barbara144 z5b MA on Fri, Aug 27, 04 at 17:01
        - 1 follow-up, posted on Fri, Aug 27, 04 at 21:33
- Any idea what kind of a bug this is?
    - Posted by: Murphette 7 on Mon, Aug 23, 04 at 12:53
        - 5 follow-ups, last one posted on Fri, Aug 27, 04 at 21:18
- how to use this container?
    - Posted by: thistle5 z7 VA on Wed, Aug 25, 04 at 12:53
        - 6 follow-ups, last one posted on Fri, Aug 27, 04 at 20:07
- hanging baskets - full sun
    - Posted by: steph_oshawa z5b/6a ON on Wed, Aug 25, 04 at 10:57

- 3 follow-ups, last one posted on Fri, Aug 27, 04 at 15:33

- Trailing Lantana in Container
  - Posted by: PattyinStLouis 5 on Mon, Aug 23, 04 at 20:00
    - 3 follow-ups, last one posted on Fri, Aug 27, 04 at 13:22
- need a suggestion for hanging basket
  - Posted by: SillyBugs z10 on Wed, Aug 18, 04 at 19:26
    - 3 follow-ups, last one posted on Fri, Aug 27, 04 at 9:56
- grasses & perennials
  - Posted by: tabassam Mid-Atlantic on Tue, Aug 24, 04 at 21:58
    - 2 follow-ups, last one posted on Fri, Aug 27, 04 at 3:52
- Ideas for a purple/gold container?
  - Posted by: debbie8592 Central FL on Tue, Aug 24, 04 at 14:53
    - 5 follow-ups, last one posted on Fri, Aug 27, 04 at 0:47
- Wave Petunias are looking sad in hanging basket. Advice?
  - Posted by: Carrie77 z6 St. Louis MO on Wed, Aug 11, 04 at 19:41
    - 11 follow-ups, last one posted on Thu, Aug 26, 04 at 10:56

Next 30 messages... | **Page: 1** **2** **3** **4** **5** **6** **7** **8** **9** **10**

Today's Birthdays!

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GardenWeb

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Please Note: Only registered members are able to post messages to this forum.

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- Before posting a message, make sure you have chosen *the* most appropriate forum from the list. Off-topic posts will be deleted at our discretion. Please do not post the same message to multiple forums.
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Container Gardening

By Kathy Reiffenstein offline

Related Subject(s): Container gardening

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De esta forma, en respuesta a la creciente pauperización del campo mexicano, el grupo ANADEGES amplió sus programas de apoyo a indígenas y campesinos que busquen fortalecer la base económica y la autonomía de sus organizaciones. Los apoyos que realizamos son de carácter técnico-educativo, financiero y logístico.

Los sujetos de los apoyos de ANADEGES son grupos, comunidades y organizaciones indígenas y de campesinos, con o sin personalidad jurídica, que cuenten con la asesoría y acompañamiento de uno o varios asesores locales con los cuales se puedan establecer vínculos de confianza.

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CYNDI'S CATALOG OF GARDEN CATALOGS

Mail-Order Gardening Resources

The home gardener's one stop to find all the mail-order gardening catalogs in the US and Canada - over 2000 of them! Check here first to find the company and see its ratings for quality, service, price and breadth of varieties. Plus links to mail-order companies outside North America, and other gardening-related sites.

Last Update August 15, 2004

The Specialist Catalogs:		The General Catalogs:	Other Links
Aquatic Bamboo Bonsai Bulbs Cactus Carnivorous Chrysanthemums Clematis Dahlias Daylilies Ferns Fruit Garden Decor Grasses Heirloom Herbs Hostas Houseplants	Iris Lilies Miscellaneous Mushrooms Natives Orchids NEW! Organic Perennials Peonies Rhododendrons/Azaleas Roses Supplies/Tools Trees/Shrubs NEW! Tropical Vegetables NEW! Wholesale Wildflowers	General: Catalogs that carry everything for the home gardener: plants & seeds of all types plus tools & supplies. Ornamental: Catalogs that carry large varieties of plants and seeds for the ornamental garden, such as annuals, perennials, trees & shrubs; very few or no vegetables. NEW! Everybody Online: All the websites for the companies in every category are listed here, in alphabetical order. NEW! Canadian: All the Canadian companies.	General Advice and How-To Regional Advice Specialty Gardening Specific Plants Critter Advice Plant Finders Other Directories

		Companies outside North America: If it's not in the U.S. or Canada, look here.	
I WANT YOUR COMMENTS!	Know of a new company? Want to comment about an existing one? Click the email link below, and let me know. For a new company I need name, address, phone, description, and URL if applicable.		

This site maintained by Cyndi Johnson. Contact Cyndi here

EMAIL TO CYNDI WILL NOT GET YOU A CATALOG. USE THE COMPANY'S INFORMATION.

That's part of my garden in the picture above, July 2000.

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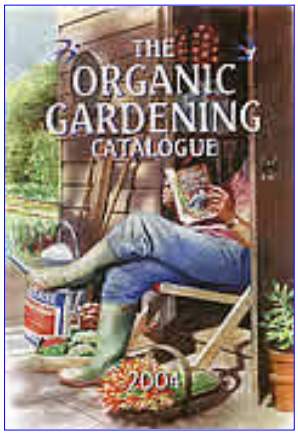

The Organic Gardening Catalogue, official catalogue of HDRA, is run as a joint venture with Chase Organics in Hersham, Surrey, UK who have been suppliers to organic gardeners for over 80 years.

We are very happy to supply both members and non-members. HDRA members receive a 10% discount on all goods.Within our shop you can find 'Everything for the Organic Gardener' - a great range of seeds, fertilisers, composts, pest controls, weed controls, tools and books - there really is something for everyone inside.

Note for members
The password to claim your members discount can be found in the HDRA's Headquarters box in the latest edition of The Organic Way, or in your New Member welcome letter.

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Welcome to our 2004 catalog!

Located inside our seed catalog are all of your favorite Territorial varieties, including vegetable seeds, flower seeds, our famous sunflower seeds, and a few specialty items such has garlic and potatoes and over one hundred transplants. And be sure you visit our organic seed section. And along with our products is enough special gardening information to publish a text book with! So please come in, explore, and enjoy yourself. And please Contact Us with any questions or comments.

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Vegetable seeds and flower seeds from the Territorial Seed catalog.

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SEEDS of CHANGE CERTIFIED ORGANIC

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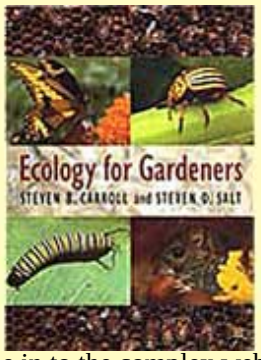
Garden Ecology: It's a wild world out there!

We hope you are enjoying the long summer days and exploring, without hoe in hand, the intricate ecology that thrives in your garden. We recently broke out our MacroScope and opened up a whole new realm of awareness as tiny blooms turned into fantastic sculptures of form and color and larger-than-life insects gathered nectar or devoured leaves. In celebration of the complexity of our garden's ecology, we offer a great new book and four new beneficial insect packages.

See eNewsletter 42 for more...

New! Book Review



Tune in to the complex web of life in your garden. Read our review of ***Ecology for Gardeners***...

Look Closer!

Our MacroScope reveals intimate details of flowers, insects, worms and more with astonishing clarity. **Get Yours**...

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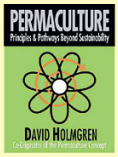

Holmgren, *Permaculture: Principals and Pathways Beyond Sustainability.*

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- David Pimintell, Ph.D., Cornell University

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CAPE Smoke Seed Primer. Jim Johnson, Seedman is now the North America Distributor for the CAPE "Instant Smoke Plus" Seed Primer that we use in our own greenhouses. We find we receive significantly better germination results when we use this primer on Musa, palms, tropical, wildflower and other types of seeds.

Dr T's Line of Pest Repellents for insect/pest control.

Jim's Plant Food Formulas Page. Special plant food blends for many of the unique plants that can be grown from our seeds.

SBE Gardening Products

Plant Gel Soil Alternative

Seeds in Retail Size Packets

All seeds are in stock and ready for shipping. Orders are shipped within 48 hours via First Class Postage. Overseas orders are shipped via Air Mail.

NEW Due to the huge number of requests we received over the winter, we've decided to bring back the very popular Vegetable Garden Seed Kit.

NEW Limited availability seeds, featuring **Tea Plant, Black Pepper Vine, Ylang Ylang Tree, Sacred Water Lily** and other rare seeds usually not found in retail markets.

Acacia Seeds

Angel's Trumpet Flower Seed Kit, contains a nice selection of Datura and Brugmansia seeds

Australian Plant Seeds Seeds from Down Under, a wonderful selection of seeds from Australia

Baby Vegetable Seeds

Banana Seed Page featuring seeds for **Scarlet Bananas, Ethiopian Bananas, Dwarf Cavendish Bananas, Rose Bananas, Velvet Pink Bananas, and Striped Banana Plants**

Bee and Butterfly Garden Seeds

Bible Garden Seeds

Birch Tree seeds from around the round

Bonsai Plant Seeds

Cacti Plant Seeds

Australian Cypress Pine (Callitris) seeds from around the world

Certified Organic Vegetable, Flower and Herb Garden Seed Selections from Ferry Morse Seeds

Certified Organic Vegetable, Flower and Herb Garden Seed Selections from Botanical Interests Seed Co.

Certified Organic Vegetable Garden Seed Selections from Burpee Seed Co.

Cherry Trees and Bush Seeds (Prunus) from around the World

Chinese/Japanese/Korean Stir-fry Vegetables

Chinese Medicinal Plant Seeds

Children's Flower Garden and Vegetable Seeds

Cold Hardy Palms, Banana, Yucca and Cycad seeds

Container Garden seeds

Cut Flower/Filler Arrangement plant seeds

Deer Resistant plant seeds

Dried Arrangements (Flowers and Fillers) plant seeds

Edible Landscape plant seeds

Eucalyptus Tree Seeds

Fall and Winter Vegetables

Flower Garden Seeds

Flower Garden Seeds from England (Sutton Seeds)

Flower Garden Seeds from Ferry-Morse

Flower Garden Seeds from Mr. Fothergill's

Flower Garden and Herb Seeds from Botanical Interests

Flower Garden Seeds from Burpee Seed Company

Flower Garden Seeds in Economy Size Packs

Flower Garden Seeds by Color

Fragrant Plant seeds

Fir Tree seeds from around the world

Fruit and Nut Plant seeds

Garden Oddity Seed Kits Due to the tremendous demand, we have made the Garden Oddity Kit#1 and now the Garden Oddity Kit #2 available as a retail item! Be the talk of the gardening community when you grow these giant and unusual

items

Garden Novelty Seeds

Garden Herb seeds

Medicinal Herb seeds from Garden Medicinal Seed Company

Garden Vegetable Seeds

Vegetable Garden Seeds from England (Sutton Seeds)

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Ground Cover plant seeds

Hanging Basket plant seeds

Hedge Plant seeds

Herbal Tea Garden plant seeds

House Plant Seeds from around the World

Lawn Shrubs and Plants from Around the World

Maple Tree seeds from around the world

Medicinal and Herbal Plant Seeds features seeds for plants described in herbalist guides and folklore

Moongarden Plant seeds

Moringa (Horseradish Tree) Seed and Info Page

Morning Glory Seeds

Native American Plants (Wetland, Prairie, Savanna and Woodland) seeds

Natural Insect Repellent Plant seeds

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Pepper Plant seeds

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Rain Forest Plant seeds

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Tomato Plant seeds

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Tropical Greenhouse Plant Seeds

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Xeriscape plant seeds

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Seeds and Products from Rachel's Supply

Gardening

Rachel's Boquet Flower Seed Mixes.

Rachel's Gourd Seeds (over 50 varieties) for decorations and crafting.

Rachel's list of Hand Collected Seeds featuring very difficult to find seeds.

Rachel's Garden Labels and Markers

Rachel's Gardening Books for and Games for Children.

Rachel's Loofah Sponge Seeds and Products.

Rachel's Regional Wildflower and Grass Mixes.

Rachel's Pepper Seeds (over 150 varieties) for the pepper lovers out there.

Rachel's Tomato Seeds (over 300 varieties) for the tomato lovers out there.

Rachel's Mushroom Plugs, Kits and supplies shipped from **Mushroom Harvest Farms**.

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New! Rachel's Decorative Metal Tins

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Note: These are not stock items, they are shipped from growers, there can be a lengthy delivery time on these seeds depending on harvest time of species.

NextHarvest.com is an affilliate company of Seedman.com and Southern Business Express. Here you can order bulk and special request seeds. This is a different shopping site, you should complete your order on this site before visiting NextHarvest.com

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HEIRLOOM SEEDS

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CALIFORNIA GROWN CERTIFIED ORGANIC SEEDS

BEANS

#O204 - BLACK VALENTINE BUSH SNAP BEAN 67 days - This heirloom variety of bean was first introduced in 1897. The dark green, stringless beans are 6" long and have exquisite flavor. Our best selling bush bean. Try some!
PKT. - 2 oz. - $2.50 (approximately 125 seeds)

#O209 - BABY BUSH LIMA BEAN 70 days - This baby lima produces 4 buttery flavored beans on each 2 1/2" long pod. This very prolific, as well as great tasting variety, has been popular since Civil War times!
PKT. - 2 oz. - $2.50 (approximately 125 seeds)

NEW **#O251 - BUTTERBEANS SOY BEAN** 90 days – The stocky, 2 foot plants will produce an abundant supply of bright green pods, many containing 3 large beans. A terrific choice for eating fresh, but also great canned or frozen.
PKT. - 1 oz. - $2.50 (approximately 100 seeds)

#O214 - DARK RED KIDNEY BEAN 95 days - A great variety for dried beans, as well as for baking, soup or chili. Each pod contains 5 large, red, kidney shaped beans. A very popular bean for Mexican cuisine.
PKT. - 2 oz. - $2.50 (approximately 150 seeds)

NEW **#0240 - DRAGON'S TONGUE BUSH SNAP BEAN** - 58 days – A fine Dutch variety of wax bean that's productive and rust resistant. The 6-7 inch pods are long and flat, with purple streaks throughout the yellow color. Crispy and stringless.
PKT. - 50 seeds - $2.50

NEW **#O244 - HIDATSA SHIELD FIGURE DRY BEAN** 90 days- These beautiful tan and white seeds were originally sowed by the Hidatsa Indians, using corn stalks

as support for this high-yielding pole variety. This was a favorite in the Buffalo Bird Woman's garden.
PKT. – 50 seeds – $2.50

NEW **#O245 - IRELAND CREEK ANNIE DRY BEAN 72 days – This reliable producer dates to the 1930's when it was grown on Ireland Creek Farm in British Columbia. The 2 foot bush plants bear an early and delicious crop. Great in soups and stews.**
PKT. - 50 seeds - $2.50

#O218 - JACOB'S CATTLE BEAN DRY BEAN 80-100 days - A very old New England favorite that can be used for baking or soup. A beautiful kidney shaped white bean that's speckled with maroon markings. A heavy yielding bush variety!
PKT. - 1 oz. - $2.50 (approximately 75 seeds)

NEW **#O246 LINA SISCO'S BIRD EGG DRY BEAN 85 days – Brought to Missouri by covered wagon in the 1880's, these large tan and burgundy seeds are a great horticultural variety. This bush-type bean will reliably produce an excellent crop grown either as a green shelling or dry bean.**
PKT. - 50 seeds - $2.50

NEW **#O247 - MARFAX DRY BEAN 80-85 days – An excellent, high-yielding bush variety that produces beautiful, gold colored soup beans. A good choice for shorter growing areas. These tasty beans have been a New England favorite for generations.**
PKT. 50 seeds - $2.50

NEW **#O248 - MAYFLOWER DRY BEAN 90 days - Brought over in 1620 on the Mayflower, this cutshort - type pole variety offers high yields and delicious taste, but has strings. An excellent choice for period gardens.**
PKT. - 50 seeds – $2.50

#O208 - OLD HOMESTEAD POLE SNAP BEAN (Kentucky Wonder) 69 days - This variety was first introduced in 1864, and is still a favorite of many. Tall vines, often growing over 6 feet tall, produce an abundant crop of 9 to 10 inch beans. Distinctive "beany" flavor!
PKT. - 2 oz. - $2.50 (approximately 150 seeds)

BEETS

#O32 - DETROIT DARK RED 55-60 days - This heritage variety was first

introduced in 1892, and is still the most popular beet grown in the U.S.A. today! These tasty, dark red, globe shaped beets make a good crop for canning or eating fresh!

PKT. –1/4 oz. - $1.85

#O38 - EARLY WONDER **50 days - The tops of these beets are tall (16 to 18" high), dark-green, and tinged with red, while the 3" globe shaped roots are a purple-red color. An excellent early variety, that also does well grown in autumn for storage.**

PKT. - 1/4 oz. - $1.85

BROCCOLI

#O301 - DE CICCO **50-60 days - This old, reliable European variety was first introduced in 1890. The compact, 2 to 3 feet plant has bluish green heads and will yield plenty of side shoots once the central head is harvested. A very productive variety that has excellent flavor!**

PKT. - 200 seeds - $2.00

CABBAGE

#O4502 – ALL SEASONS **85-95 days - A sure heading variety with large, 10-12 pound round, but flattened heads. A very good flavored cabbage that has shown some heat resistance.**

PKT. – 200 seeds - $1.85

CARROTS

#O401 - DANVERS HALF LONG **75 days - This old favorite was first introduced in 1871, and continues to do well today! The smooth, red-orange skin with bright orange flesh measures 6 to 8 inches long, by 2 inches wide, and is semi-blunt ended. A very flavorful variety!**

PKT. - 1200 seeds - $1.85

#O404 - LITTLE FINGER **50-65 days - This French variety makes delightful baby gourmet carrots! Its tiny roots grow only 3-5 inches, with a wonderful, deep orange color. Can be planted a little closer together than our other carrots, getting a larger harvest from the same amount of garden space!**

PKT. - 1200 seeds - $1.85

CELERY

#O07- UTAH **70-125 days – Crunchy and stringless, this vigorous green variety has**

thick, well-rounded stalks and tightly folded hearts. Great grown for fall use!
PKT. – 400 seeds - $1.85

CORN

NEW **#O561 - ASHWORTH** **70-85 days – This New York heirloom produces sweet, 7 inch ears filled with crisp, golden colored kernels. A great early variety that has excellent flavor.**
PKT. - 1 oz. - 2.50 (approximately 100 seeds)

#O52 - COUNTRY GENTLEMAN **95 days - This old fashioned, shoe peg variety was first introduced in 1890. The 7 to 8 foot stalks produce 7 inch, irregularly spaced, white kernels. An excellent tasting corn either fresh from the garden or canned!**
PKT. - 1 1/2 oz. - $2.50 (approximately 150 seeds)

CUCUMBER

NEW **#O519 - BOOTHBY'S BLONDE** **60 days – This heirloom originated from the Boothby family of MAINE. The 6-8 inch creamy yellow fruits are crisp and tasty, with small, black spines. A good slicing cuke.**
PKT. - 30 seeds - $1.85

#O504 – LEMON **65 days - This old heirloom variety was first introduced in 1894. The small, lemon shaped cucumbers are pale yellow when mature, with mild, crisp, white flesh. Very unique!!**
PKT. - 60 seeds - $1.85

#O507 - STRAIGHT EIGHT **65 days - This "All American Selection" from 1935 grows smooth, straight, dark green fruits about 8" long. A very vigorous, prolific cucumber that is an excellent home garden variety!**
PKT. - 60 seeds - $1.85

EGGPLANT

#O26 - LONG PURPLE **80 days - This favorite Italian variety grows fruit 8 to 10 inches long and 2 ½ inches in diameter. Four or more dark purple fruits grow on each of these 25 to 35 inch plants. Delicious!**
PKT. - 25 seeds - $2.00

KALE

#O3007 - WINTER RED 50 days - The dark green, oak leaf type leaves are richer in vitamins and minerals than other varieties of kale. The red and purple leave colors intensify after a fall frost, giving way to a sweet, rich, tender taste after cooking! A good disease resistant variety.

PKT. - 200 seeds - $1.85

LEEKS

NEW **#O4201 - AMERICAN FLAG** 85–135 days - This early variety is especially suited for the home gardener. The large, thick, extra long stems (10 x 1½ inches) have a delicious pearl-white bulb and large, green leaves. A hardy variety of leek with a mild, delicate onion flavor!

PKT. - 300 seeds - $1.85

LETTUCE

NEW **#O6044 - CRISP MINT** 63 days - Tasty and sweet, this romaine variety can reach 10 inches in height. The crispy leaves have a slightly serrated edge and is a terrific choice to mix with other lettuces in salads.

PKT. - 200 seeds - $1.85

#O60 - BLACK SEEDED SIMPSON LETTUCE 43 days - A very early variety first introduced in 1850. An easy to grow leaf lettuce, with light green frilled leaves. A very crisp and tasty choice. An old favorite!

PKT. - 750 seeds - $1.85

#O6003 - BUTTERCRUNCH 65 days - A large, heat resistant butterhead type that was an " All American Winner" in 1963. The compact heads have thick, juicy, crisp green leaves tinged in red, with a compact yellow-white heart. A heat tolerant variety.

PKT. - 750 seeds - $1.85

#O66 - PARIS WHITE COS 70 days - A very popular variety of romaine lettuce that dates from the 1860's. The 8 to 10 inch plants have light green crinkled leaves, a white core, and are wonderful in a salad!

PKT. - 750 seeds - $1.85

NEW **#O6047 YUGOSLAVIAN RED BUTTERHEAD** 55 days - Extremely decorative, this beautiful butterhead produces burgundy tinged leaves on loose heads. Sweet and tender; a wonderful addition to the salad bowl.

PKT. - 200 seeds - $1.85

SALAD GREENS

#O6017 – GOURMET SALAD BLEND **45–60 days - A colorful blend of lettuce varieties in shades of green and red. The ruffled edges and unique leaf shapes provide an interesting texture and fancy appearance!**

PKT. – 400 seeds - $1.85

#O6018 – MESCLUN MIX BLEND **50–60 days - A colorful mixture of lettuce, chicory and other greens for an unusual salad having color, texture and a special flavor. A real taste treat for any salad lover!**

PKT. – 400 seeds - $1.85

#O6101 - ARUGULA **40 days - This tasty little green will spice up any salad! The dark green, lobed leaves have a sharp, "peppery" taste. Sow every 3 weeks for a continuous harvest. Best picked at 2-3" tall.**

PKT. – 300 seeds - $1.85

MELON

#O655 - HEARTS OF GOLD **88 days - This very popular old-timer was first introduced in 1890. The 3 pound melons have thick, fine grained, salmon -orange colored flesh, with a unique, spicy flavor!**

PKT. - 30 seeds - $2.00

MUSTARD GREEN

#O3010 - SOUTHERN GIANT CURLED **50 days - This slow-bolting variety is an excellent choice for southern states. The mildly flavored plants grow 18-24 inches, and have large, bright green, curled leaves.**

PKT. - 200 seeds - $1.85

OKRA

#O3013 - CLEMSON SPINELESS **60 days - This "All American Selection" winner was first introduced in 1939. The 4 foot plants produce ample amounts of dark green, high quality pods. Best picked when pods are 2 1/2 to 3 inches long. The most popular okra grown in the U.S. today!**

PKT. - 25 seeds - $1.85

ONION

#O4001 - EVERGREEN WHITE BUNCHING **65-120 days - An excellent choice for green onions! This variety forms clusters of 4-9 long, slender, silver-white stalks. A delicious, non-bulbing onion that is slow to bolt.**
PKT. - 400 seeds - $1.85

ENGLISH PEAS

#O715 - LAXTON'S PROGRESS #9 **58-65 days - A large, English pea that grows on plants 15 to 20" high. The 5" pods are bursting with 6 to 9 large size, dark green peas. This variety produces a fine crop that has both excellent flavor and quality. Originally developed in Britain.**
PKT. - 2 oz. - $2.50 (approximately 225 seeds)

NEW **#O716 - BRITISH WONDER** **50-55 days - First introduced to England in 1890, this high yielding variety bears very sweet and tasty dark green peas, on 2 to 3 foot vines. A good choice for freezing.**
AVAILABLE SOON

SNAP PEAS

NEW **#O717 AMISH SNAP** **60 days – An old variety grown for years in the Amish community. The tall, 6 foot vines need plenty of support, and produce sweet, 2 inch pods. Long yielding if kept well picked.**
PKT. - 50 seeds - $2.50 (approximately 225 seeds)

#O714 - OREGON SUGAR POD **60-70 days - A bush sugar snap pea with some disease resistance that grows 24 to 30 inches high. The succulent pods are 4 1/2 inches long, sweet, and filled with 6 to 8 peas. An excellent variety either raw or cooked.**
OUT OF STOCK

SNOW PEAS

NEW **#O718 - GOLDEN SWEET EDIBLE PODDED** **65 days – From India,**

this edible podded variety is both tasty and ornamental. The delightful flowers are bi-colored in shades of violet, with lemon-colored pods. The tall, 5 ½ to 6 foot vines need support. A great choice for stir-frys.

PKT. - 50 seeds - $2.50

PEPPERS (HOT)

NEW **#O7045 - CYKLON** **80 days - A Polish favorite for using fresh or dried. The tapered 2 x 5 inch, long red fruits deliver the perfect amount of heat, while still tasting good. A very prolific variety.**

PKT. - 20 seeds - $2.50

#O7001 - JALAPENO **70 days - A very popular hot pepper, used often in Mexican cuisine. The green, sausage shaped fruits are abundant on these 24-36 inch plants. Excellent variety for pickling!**

PKT. - 25 seeds - $2.50

#O7007 - LONG RED CAYENNE **75 days - These fiery hot, 5 inch peppers are long, thin, curved andwrinkled. They first appear a waxy green color, turning crimson at maturity. Choose this variety for crushed red peppers!!**

PKT. - 25 seeds - $2.50

PEPPERS (SWEET)

#O75 - CALIFORNIA WONDER **75 days - Our select strain of this popular bell pepper! This large, thick walled, juicy, sweet pepper is the most popular variety grown in the United States today! A delicious, 4 inch pepper that starts out green when young, turning a bright red at maturity. Delicious!**

PKT. - 25 seeds - $2.50

#O77 - CALIFORNIA WONDER GOLD **72 days - Similar to California Wonder pepper, except the fruits ripen to a bright yellow-gold color. The beautifully colored 4" fruits weigh 6 ounces each, and grow on plants that are 24 to 30 inches tall.**

PKT. - 20 seeds - $2.50

PUMPKIN

#O82 - BIG MAX **120 days - Huge pumpkins grow 100 pounds or more! The fruits are nearly round, with slightly rough red-orange skin. Good for pies or canning. Great for**

mammoth jack-o-lanterns!
PKT - 10 seeds - $1.85

NEW **#O88 CHEYENNE BUSH PUMPKIN** *(Cucurbita pepo)* **80-90 days - A terrific choice for those with a shorter growing season or limited growing space. This early variety delivers high yields of 7 pound fruits on smaller, bush vines.**
PKT - 10 seeds - $1.85

#O80 - NEW ENGLAND PIE 105 days – This bright orange, 5-8 pound pumpkin is ideal for pies as well as mini jack-o-lanterns. Delicious flavor!
PKT. - 15 seeds - $1.85

RADISH

#O812 - CHERRY BELLE 20 days - This radish was an "All American Selection" winner in 1949, and is an early variety, taking only 20 days to mature! A very prolific radish, with deep red skin and crisp white flesh. Try some!
PKT. - 350 seeds - $1.85

#O802 - FRENCH BREAKFAST 23 days - This heirloom was first introduced in 1880, and many still consider it to be their favorite! This oblong radish grows 1 1/2 to 2 inches, and is a pretty, bright red color with a white tip. A very mild and sweet choice!
PKT. - 350 seeds - $1.85

SOUTHERN PEAS

#O3040 - CALIFORNIA BLACK EYE PEA 65 days - This all time southern favorite can be used either green in the summer or dried in the winter. This heavy yielding, sweet flavored variety has 6 to 7 inch, well filled pods.
PKT. - 2 oz. - $2.25

SPINACH

#O913 - BLOOMSDALE LONG STANDING 46 days - This heirloom variety was first introduced in 1908 and still remains very popular! The thick-textured leaves are of fine quality, very crinkled and dark green in color. A slow bolting spinach that is heavy yielding. Excellent variety for either fresh or canned!
PKT. - 400 seeds - $1.85

SQUASH - Summer

#O93 - DARK GREEN ZUCCHINI 55 days - This variety was first introduced in 1931, and is still one of our most popular squash! The bush plants take up less room in the garden, while still producing plenty of straight, smooth, dark green mottled fruit with green-white interiors. A very prolific variety that has excellent taste!
PKT. - 20 seeds - $1.85

#O92 - YELLOW CROOKNECK 60 days - This old variety has a distinctive buttery flavor and is deep yellow in color, with a curved neck and plump blossom end. For a continuous harvest all summer long, pick when the squash are 6 inches long. Simply delicious!
PKT. - 20 seeds - $1.85

SQUASH - Winter

#O9001 - BUTTERNUT 90 days - This all time favorite is a light tan color, with rich golden-orange flesh. The bottle shaped fruit average 3 to 5 pounds each, and are great tasting! A good variety for winter storage!
PKT. - 20 seeds - $1.85

SWISS CHARD

#O1015 - FORDHOOK GIANT 55 days – Introduced in 1934, the broad, dark green, heavily crinkled leaves grow on thick, white, 24-28 inch stalks. Grow delicious greens throughout the entire gardening season!
PKT. -1/4 oz. - $1.85

#O1025 - RUBY RED 55 days - Tender, sweet chard with delicious red stalks! The dark green, heavily crumpled leaves grow on plants 18 to 24 inches tall. A unique home garden variety that grows well in spring, summer or fall!
PKT. - 1/4 oz. - $1.85

TOMATO

#O137 - BESSER 75 days - From the Freiburg region of Germany, this old favorite dates back to the 1800's. The plants produce very sweet, ¾" fruits, in clusters of up to 12. First introduced by Heirloom Seeds. A must for the tomato lover! Indeterminate vines.
PKT. - 20 seeds - $2.50

#O100 - BRANDYWINE (Sudduth's Strain) 90 days - From the legendary Ben Quisenberry collection, we now offer this great tasting Brandywine variety! Mr. Quisenberry obtained this variety from Dorris Sudduth Hill in 1980, who's family took pride

in growing for over 80 years. This large, pink beefsteak variety is considered by many to be the best tasting pink tomato. The luscious fruits can weigh up to 2 pounds and have an intense, rich tomato flavor. Indeterminate vines.

PKT. - 20 seeds - $2.50

#O148 - GIANT BEEFSTEAK 100 days - This very heavy producer of large, brilliant red tomatoes has been a favorite for years! The solid, meaty fruits are 12 ounce to 2 pounds in size, and are excellent for slicing. Indeterminate vines.

PKT. - 25 seeds - $2.50

NEW **#O1036 - OPALKA 85 days – This Polish paste variety produces high yields of 3 x 5 inch great tasting fruits on its large, wispy vines. Delicious eaten fresh, but also a good choice for sauces due to its few seeds. Indeterminate vines.**

PKT. - 20 seeds - $2.50

#O112 - PINK BRANDYWINE 80 days - Introduced in the 1890's, the large vines have potato-leaf like foliage and pink fruit that weigh 1.5 pounds or more! The slightly lobed fruit is mild and juicy, with a low acid taste. We highly recommend this old-time variety! Indeterminate vines.

PKT. - 20 seeds - $2.50

#O147 - ROMA 78 days - The standard paste tomato for making sauces and catsup! The strong vines yield up to 200 red, pear shaped fruit, each weighing 2 to 3 ounces each, with firm flesh and few seeds. A very popular variety! Determinate vines.

PKT. - 25 seeds - $2.50

TURNIP

#O3031 - PURPLE TOP WHITE GLOBE 55 days - America's favorite turnip! This heirloom turnip was first introduced in 1870, and still produces an excellent crop. The smooth, round, white fleshed roots with purple tops measure 4 to 5 inches and are sweet and tasty!

PKT. - 200 seeds - $1.85

WATERMELON

#O2004 - MOON and STARS 95 days - This legendary Amish heirloom has dark green skin with a yellow "moon and stars" pattern on the rind and leaves. The bright red flesh is exceptionally sweet tasting! These tasty melons weigh between 30-40 pounds each.

PKT. - 10 seeds - $2.00

ORGANIC FERTILIZERS

Fertilizer can only be shipped to the 48 continental United States.

TOMATO FOOD - 100% organic fertilizer

This special formula (3-5-6) is "just right" for getting the most production out of your tomato plants and is made from 100% natural, all organic products. It has a lower nitrogen, but higher potash content for the best tomatoes you've ever grown! High in organic matter and humus, it will supply your tomatoes with all the plant nutrients and micronutrients they will need. The perfect alternative to harmful chemical fertilizers! This organic fertilizer will not "burn" your young transplants and will not harm the helpful organisms already present in your soil.
4 pound bag.
TF4 - $7.95

SUPER TEA

A general purpose fertilizer (5-5-1) which features high nitrogen Mexican bat guano. Also includes soluble seaweed, compost, worm casings and seabird guano. Highly soluble and odorless. Mix 1 to 3 tablespoons to a gallon of water. Fertilize while watering your plants!
2 pound package.
SRT-1 - $16.99

BUDSWELL

High phosphorus formula (0-7-0) is one of the finest organic flowering fertilizers on the market today. Promote more and bigger blooms in your flower garden! Will also promote higher yields from flowering vegetable varieties (beans, cucumbers, eggplants, melons, peppers, squash, tomatoes, etc.). Highly soluble and odorless. Mix 1 to 3 tablespoons to a gallon of water. Fertilize while watering your plants! 2 pound package.
BSWL - $16.99

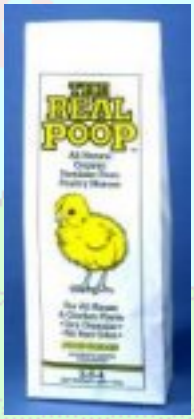
HERB FOOD

Premium quality food for edible herbs. This all natural, organic, slow release fertilizer is perfect for growing lush herbs indoors. Specifically designed to enhance flavor and fragrance of all herbs. Simply sprinkle one to three tablespoons (depending on container size) of fertilizer around each herb plant.

With an analysis of 5-1-5, this formula provides all the nutrients to grow bigger, more flavorful herbs! 1.25 pound container.

HBF - $6.99

THE REAL POOP - 100% organic fertilizer



All-purpose, all natural, organic fertilizer from poultry manure. The 3-5-3 formula is great for fertilizing your vegetables, flowers or herbs - even great for house plants! This organic fertilizer will not "burn" your young transplants and will not harm the helpful organisms already present in your soil. The "Real Poop" is high in organic matter and humus, supplying your plants with all the plant nutrients and micronutrients they will need.
4 pound bag.

RP4 - $7.95

VEGETABLE FOOD - 100% organic fertilizer

This balanced fertilizer (5-5-5) can be used throughout the garden on all your vegetables, and is made from 100% natural, all organic products. It will supply your vegetables with all the plant nutrients and micronutrients they will need. Grow your best garden ever without the use of harmful chemical fertilizers! Organically grown produce is healthier and friendlier to our environment. 4 pound bag.

VF4 - $7.95

PERUVIAN SEABIRD GUANO

The perfect all natural, 100% organic fertilizer. Use it inside or outdoors, there is nothing that can compare to Peruvian Seabird Guano for accelerating plant growth and improving plant vigor. 11-13-3 formula is "just right" for all your flowering vegetables, such as tomatoes, peppers, eggplants, etc. Also does wonders for your annual and perennial flowers. Contains important trace elements. Just add one to three tablespoons per gallon of water to

feed your plants. Nothing could be easier! 2.2 pound bag.

PSG - $9.95

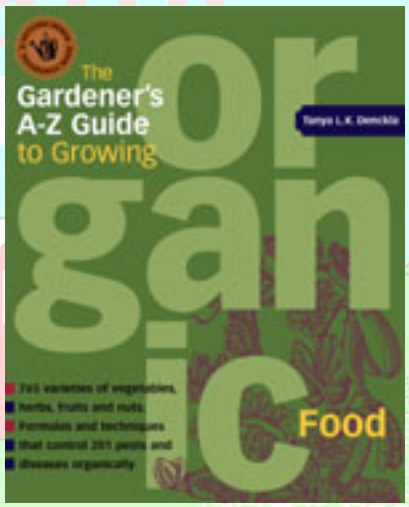
INDONESIAN BAT GUANO

From the Far East comes Indonesian Bat Guano (0-13-0) with the highest phosphorus rating available in guano. It is perfect for encouraging multiple blooms and hardy root growth. One hundred percent organic and suitable for all indoor and outdoor plants. May be dissolved in water or applied as a top dressing for slow release. Great for producing heavier yields of tomatoes, peppers, cucumbers, melons etc.! 100% organic - 2.2 pound bag

IBG - $9.95

THE GARDENER'S A–Z GUIDE TO GROWING ORGANIC FOOD

by Tanya L. K. Denckla



Enjoy guaranteed organic produce with this comprehensive plant-by-plant reference for how to select, grow, harvest, and store more than 765 varieties of vegetables, herbs, fruits, and nuts. Also included are more than 100 up-to-the-minute organic remedies for 201 diseases and pests. This is the book to demystify the complex organic systems of the garden, and make healthful vegetable gardening easier and more fun.

Trade paper cover - 496 pages, two-color illustrations throughout.

ORF - $22.95

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by Edward C. Smith

Discover Ed's High-Yield Organic System for growing your best garden ever! Ed's four simple principles - Wide Rows, Organic Methods, Raised Beds and Deep Soil - are all thoroughly covered. This book will help anyone have the best, most productive garden ever! Learn how to grow healthier plants with less weeds, less pests and less disease without

the use of harmful pesticides or chemicals. Practical information on most vegetables and herbs from artichokes to watermelons. *Organic pest control methods, using compost, raised beds, wide row planting and many more organic growing methods.* A must book for any backyard gardener! 310 pages with hundreds of color photographs. Trade paper cover.

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How to Obtain our Printed Catalog

NEW FOR 2004

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Visit our sister site at: www.heirloomtomatoes.com

Appropriate Technology Transfer for Rural Areas

Suppliers of Seed for Certified Organic Production

(Including Untreated and Non-GMO Seed)

Horticulture Resource List

ATTRA--National Sustainable Agriculture Information Service
PO Box 3657
Fayetteville, AR 72702
Phone: 1-800-346-9140 --- FAX: (479) 442-9842

By Katherine L. Adam and Nancy Matheson
NCAT Agriculture Specialists
March 2004

Summary: *The purpose of this publication is to help U.S. farmers find quality organic seed of regionally suitable varieties. The following list, originally a listing of small alternative seed companies offering open-pollinated, heirloom vegetable seed, has expanded over the years to include suppliers of seed for agronomic crops—with a recent focus on sources of seed certified organic or otherwise acceptable in accordance with the 2002 National Organic Program regulations.*

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Additional Seed Supplier Lists

Introduction

Since implementation of the National Organic Rule went into effect October 21, 2002, farmers have been required to use organic seed for organic crops—unless that seed is "not commercially available" for a given crop. This regulation is open to interpretation. For example, State of Montana Organic Certification Program Manager Doug Crabtree writes:

> *Please note that you do NOT have to purchase organic seed IF it is not commercially available in appropriate form, quality, quantity or variety to fit your Organic Production System Plan. For instance, you do not have to buy organic wheat seed in 1 oz. packets to plant 500 acres if that is the only quantity in which it is available. You do not have to buy organic sprouting alfalfa seed for your hay field if that is the only form in which it is available. You do not have to buy dirty, low-germination or non-certified organic seeds if that is the only quality available. Whatever the reason for not using organic seed, you (the producer) must document what the reason(s) are and that you did search for organic seed before using non-organic.* (1)

Farmers should first contact their certifying agency or state department of agriculture to find out if these agencies can supply lists of seed sources for organic production of their region's leading crops. Not all states have organic certification programs.

The Organic Materials Review Institute (OMRI) publishes a list of sources of organic seed on its regularly updated website. Seed companies meeting OMRI requirements may be listed for a fee. Membership in OMRI is not required to view this list. As of October 20, 2002, OMRI requires all seed companies listed to have a certificate of organic certification on file, in compliance with the requirements of the Final Organic Rule.

This is not a complete listing of all seed suppliers. There are many types of seed suppliers. The emphasis in this publication is on national companies, especially mail order. NCAT is not aware of all local or regional seed suppliers. Most suppliers specialize in one of the broad seed categories—agronomic or horticultural—and the following categories reflect that. NCAT has not inspected the certificates of any company listed herein or their certifiers, nor does the following listing make or imply any claims about the trustworthiness or business practices of any company. No matter what the source, seed buyers need to ask pertinent questions and study the label (especially for bulk seed). Organic producers are strongly encouraged to ask first for organic seed and to demand a label with percentage of pure live seed.

Principally for agronomic crops, certified seed (as distinguished from certified organic) must meet minimum standards for germination, cleanliness, and labeling. Bin-run seed, bought locally from farmers, requires extra caution—even though it may have been organically produced. Organic farmers are well advised to learn techniques of seed-saving and seed production. A series of workshops on these topics are planned for 2004 in parts of the Pacific Northwest, a traditional area for seed production. Other workshops are being held in the Northeast. Contact the Organic

Seed Alliance (See Table 3 below) for more information.

The seed buyer needs to ask to see his supplier's documentation. Ask: Is this seed organic? Certified by whom? If not, is it untreated; is it GMO-free? Is it pre-inoculated (in the case of legumes), and if so, is the inoculant GMO-free? The farmer ***must*** get a copy of the inoculant label to verify that it is GMO-free. What is the percentage of pure live seed? What is the percentage of contamination?

Please note that Table 1 (Agronomic) includes a wide range of suppliers—not just certified organic handlers or suppliers. Table 2 includes suppliers of organic seed for horticultural crops. Table 3 is our traditional listing of small, alternative seed suppliers specializing in untreated, non-GMO seed for open-pollinated and heirloom vegetable varieties.

Organic Certification addresses a process

It is important to recognize that organic certification addresses the ***process*** involved in producing and handling a product. Organic certification assures the consumer that the product was grown using organic methods, that synthetic pesticides, fertilizers, and genetically engineered organisms were not used in production, and that pains were taken to prevent contamination from the outside. The organic process does not guarantee that the product is completely free of all pesticide residues or GMO contamination. Only a lab test can do that. (The vast proliferation of pesticides and GE crops precludes virtually everyone from making such a claim.)

Organic certification also does not ensure that the products are nutritionally superior. However, organic farmers and consumers firmly believe that organic food and feed is healthier, and that organic production is better for the environment. Furthermore, organic farming brings important social and economic benefits. Lower production costs and organic premiums give farmers more equitable returns to their labor and management. By making smaller farms more economically viable, organic farming helps preserve family farms and rural communities.

What the New Rule Says

a) The producer must use organically grown seeds, annual seedlings, and planting stock, Except, That,

(1) Nonorganically produced, untreated seeds and planting stock may be used to produce an organic crop when an equivalent organically produced variety is not commercially available, Except, That, organically produced seed must be used for the production of edible sprouts;
(2) Nonorganically produced seeds and planting stock that have been treated with a substance included on the National List of synthetic substances allowed for use in organic crop production may be used to produce an organic crop when an equivalent organically produced or untreated variety is not commercially available.
(3) Nonorganically produced annual seedlings may be used to produce an organic crop when a temporary variance has been granted in accordance with § 205.290(a)(2);
(4) Nonorganically produced planting stock to be used to produce a perennial crop may be sold, labeled, or represented as organically produced only after the planting stock has been maintained under a system of organic management for a period of no less than 1 year; and
(5) Seeds, annual seedlings, and planting stock treated with prohibited substances may be used to produce an organic crop when the application of the materials is a requirement of Federal or State phytosanitary regulations.

—National Organic Rule §205.204 Seeds and planting stock practice standard.
http://www.ams.usda.gov/nop/

A list of certifier applicants, as well as the status of their applications, can be viewed at The National Organic Program website <http://www.ams.usda.gov/nop/>. Complete text of the Final Rule can also be found at that site.

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Genetically Modified Organisms (GMOs)

The National Organic Program Final Rule does not allow the use of Genetically Modified Organisms (GMOs), including genetically engineered crops.

If you are growing certified organic crops in 2002 and planning to save seed for next year's planting, some precautions need to be taken in regard to GMOs. There is always a chance of stray GMO material being brought in on pollen, or mixed in during harvest, transit, and storage of your crop. Organic Inspector Jim Riddle has compiled the following suggestions to minimize GMO contamination of organic farm products. (Other issues pertaining to organic seed production are addressed in the Organic Crops Checksheet, available from ATTRA in late spring 2002.)

1. **Know your seeds.** Prior to planting, verify that non-GMO seeds will be used. Obtain statements from seed companies concerning the non-GMO status of the varieties to be planted. Have seeds tested [especially if you are saving your own seed] for all applicable GMO "events." Retain copies of test results and letters from seed suppliers.

2. **Know your farm.** Know your fields and determine which have the lowest risk of GMO contamination. Select isolated fields for wind and/or insect pollinated crops (corn, canola, etc.). Know the prevailing wind direction. Establish physical buffers, such as windbreaks and hedgerows.

3. **Know your neighbors**. Establish good lines of communication with neighbors, especially those who directly adjoin organic fields. Notify them that you are an organic farmer, and where your organic fields are located. Get to know farmers who farm adjoining fields, even if they rent the land. Post "Organic Farm" signs along field margins, where needed.

4. **Know your neighbors' crops**. Gather information from neighbors, seed dealers, and farm input suppliers on the types of crops being grown in the vicinity. Know which GMO events are being planted. If neighbors are growing Bt crops, ask them to plant their "20% non-Bt refuges" in areas that adjoin organic fields, to provide some buffer protection. If possible, delay your planting dates so that your organic crops do not pollinate at the same time as GMO crops.

5. **Know your equipment**. Know what your equipment is used for. This includes rented and borrowed equipment and equipment used by custom operators. Know how to clean all pieces of equipment, including planters, combines, wagons, trucks, etc. Clean equipment prior to use in organic fields, and keep records to document your equipment cleaning activities.

6. **Know your harvest**. Submit samples prior to harvest for GMO testing. If contamination is likely, collect samples along a grid pattern, going from areas with the highest risk to areas with low risk. Submit the samples separately, in case part, but not all, of the field is contaminated. Make sure samples are tested for all applicable GMO events. Keep copies of test results.

7. **Know your crop storage**. Carefully inspect storage units prior to use. Dust from GMO crops can contaminate organic crops. Thoroughly clean augers, bins, grain dryers, rotary screen cleaners, etc.—especially if they might have previously been used for GMO crops.

8. **Know your truckers**. Carefully inspect and clean trucks and trailers prior to loading with organic grain. Make sure that transport units, including overseas shipping containers, are free of grain, dust, and other foreign material. Keep records to document, including clean transportation affidavits and bills of lading.

9. **Know your records**. Document your efforts to minimize GMO contamination. With good records, you will have a better chance of limiting losses, identifying causes of problems, and determining liability. Valid records of organic yields and sales may help establish claims for losses, should contamination occur.

10. **Know your buyers**. Know the contract specifications under which the organic crop is being grown. Know your buyer's sampling and testing protocols. Know the market-driven GMO rejection levels (tolerances) for the crops grown. Communicate with buyers and organic certifying agents concerning GMO contamination issues.

—Jim Riddle (used by permission)

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Additional Resources

Lindholm, Nicholas. 2000–2002. Organic Seed Crop Production in the Northeast [Overview, series of articles]. Maine Organic Farmer & Gardener.

September–November, 2000. Research overview.
December–February, 2000. Tomatoes.
March–May, 2001. Cucurbits. p. 30–32.
June–August, 2001. Lettuce. p. 26–28.

September–November, 2001. Beans/Peas.
December–February, 2001. Brassicas.
March–May, 2002. Flowers. p. 31–33.

Related NCAT/ATTRA Publications
Suppliers of Plugs for Medicinal Herb Crops *Organic Plug and Transplant Production* *Genetic Engineering of Crop Plants* *NCAT's Organic Crops Workbook*

Table 1. Suppliers of Seed for Agronomic Crops.

Note: It is wise to contact your seed supplier more than a year in advance of planting to contract for organic seed production and delivery.

Agassiz Seed & Supply 445 7th Street NW West Fargo, ND 58078 701-282-8118	**Order:** phone, pick up **Quantity:** wholesale **Notes:** Grains.
Albert Lea Seed House 1414 West Main Street P.O. Box 127 Albert Lea, MN 56007 800-352-5247 Fax: 507-373-7032 e-mail: mac@alseed.com http://www.alseed.com	**Order:** mail, phone, website **Catalog:** print, website **Quantity:** wholesale **Notes:** Now an NC+ Organics dealer.
Big Sky Wholesale Seeds, Inc. Box 852 Shelby, MT 59474 406-434-5011 e-mail: seeds@bigskyseeds.com	**Order:** e-mail **Quantity:** wholesale **Notes:** Alfalfa, clovers.

Blaine's Best Seeds
6020 22nd Avenue
Rugby, ND 58368
701-776-6023 (phone/fax)
701-208-0061 (cell)

Order: mail, phone

Catalog: print

Quantity: wholesale

Notes: Certified by FVO-International Certification Services. Small grains, dry beans, and legume crops (no corn, no soybeans). Certified GMO-free, also.

Brown Seed Farms, Inc.
N1279 530th Street
P.O. Box 7
Bay City, WI 54723
e-mail: e-mail: info@brownseed.com
http://www.brownseed.com

Order: e-mail, on-line

Quantity: wholesale

Notes: Corn, alfalfa.

Buckwheat Growers Association of Minnesota
20415 County Road 2
Aldrich, MN 56434
218-445-5475
Fax: 218-445-5673
e-mail: deebilek@wcta.net
http://www.buckwheatgrowers.com

Order: phone, e-mail (buyer picks up or arranges shipping)

Catalog: website

Quantity: wholesale seed and feed

Notes: Buckwheat, winter rye, red clover and hairy vetch certified organic by OCIA International. Also handles untreated, non-GMO seed (above types, plus hull-less and other oats, Legend brand seed for corn and soybeans). Farmer-owned and operated cooperative.

Butterworks Farm
421 Trumpass Road
Westfield, VT 05874
802-744-6855

Order: call for information

Catalog: call for information

Quantity: wholesale

Notes: Organic grains.

Cashton Farm Supply/CFS Specialties, Inc.
199 Front Street
Cashton, WI 54619
608-654-5123
800-822-6671
Fax: 608-654-5696

Order: phone, fax

Catalog: call for quotes

Quantity: wholesale

Notes: Organic seed and other services for organic growers in the Upper Midwest. MOSA certified. O-P seed corn, alfalfa, food grade soybean seed.

Champlain Valley Milling
P.O. Box 454
Westport, NY 12993
518-962-4711

Order: call for information

Catalog: call for information

Quantity: wholesale

Notes: Organic grains and cover crops.

Christie Farms
38165 Richardson Gap Road
Scio, OR 97374-9756
503-394-3192
Fax: 503-394-2631
http://www.bigtrefoil.com

Order: on-line

Quantity: retail or wholesale

Notes: Open-pollinated trefoil.

DLF International Seeds
P.O. Box 229
Halsey, OR 97348
541-369-1841

Order: see website

Catalog: see website

Quantity: wholesale

Notes: Organic forage seeds.

Earthwise Processors LLC.
Moorhead, MN 56560
218-287-5510
e-mail: info@earthwisepro.com
http://www.earthwisepro.com/ProductList.htm

Order: on-line

Catalog: on-line

Notes: Soybeans, corn, small grains, oilseeds, legumes.

Fedco
Organic Growers Supply
PO Box 520
Waterville, ME 04903
207-873-7333
http://www.fedcoseeds.com

Order: mail, phone

Catalog: on-line (combined print catalog with seed and potato divisions)

Notes: Accredited certifier is MOFGA. Wide variety of forage, feed, and cereal grains. Northeast regional focus, but supplies U.S. and Canada.

Foundation Direct Seeds
Mid State Supply, Inc. (Distributor)
P.O. Box 70
Sartell, MN 56377
877-464-3782

Order: call for instructions

Catalog: seedlist available

Quantity: wholesale

Notes: 6 improved organic corns; one organic alfalfa.

Goerger Farms, Inc.
15910 81 R. Street SE
Wyndmere, ND 58081
701-439-2875

Order: phone, pick up

Notes: Organic wheat.

Grassland Central
16690 Greystone Lane
Jordan, MN 55352
877-560-5181

Order: phone, pick up

Notes: Turf seed, native and reclamation grasses, wildflower and farmscape mixes. Organic clover and alfalfa.

Great Harvest Organics
6803 E. 276th St.
Atlanta, IN 46031
Contact: Dave Booher
317-984-6685
Fax: 317-984-8798
cell: 317-281-5072
e-mail:
david@greatharvestorganics.com
http://www.greatharvestorganics.com

Order: fax, phone

Catalog: on-line

Quantity: wholesale

Notes: Certified by QAI. Organic hybrid corn, soybeans, alfalfa, soft red wheat.

Gries Seed Farm, Inc.
348 N. Fifth St.
Fremont, OH 43420
800-472-4797

Notes: Organic soybeans, wheat, spelt, clover, and alfalfa.

Igl Farms
Tom and Brian Igl
W9689 Cherry Road
Antigo, WI 54409
715-627-7888
e-mail: bigl@g2a.net

Order: phone

Quantity: bulk

Notes: Certified Organic by Midwest Organic Services Association (MOSA)
Available:
Organic field pea seed.
Yellow-seeded varieties: 'Integra' (lg. seed) and 'SW Circus' (med. seed) determinate, white-fl., semi-leafless varieties bred for dry grain production, food grade or feed. Stand well, good disease tolerance and yield potential. Limited quantity 'Integra'; 'SW Circus' potential forage pea. Contact for growing/feeding information, as well as feed tests from peas grown on farm over last 4 years.
Organic Jerry oats. White-seeded oat (North Dakota release). Seed is not blue tag certified, but is cleaned and germination tested.
Organic seed potatoes. Red, Yukon Gold, Russet. Not blue tag certified, but are from foundation seed lots we planted. We have been having them virus tested, and customers have been satisfied with their performance.

Kaltenberg Seed Farms 5506 State Hwy. 19 Waunakee, WI 53597 800-383-3276 http://www.kaltenbergseeds.com	**Notes:** Organic soybeans (food grade), untreated corn, and alfalfa.
L.D. Oliver Seed Co. P.O. Box 156 Milton, VT 05468 800-624-2952 (VT only) 802-893-2739 Fax: 802-893-2194	**Order:** phone, fax, pick-up **Quantity:** retail or wholesale **Notes:** Primary business is organic fertilizers/amendments. Carries both untreated and certified organic seed (forages, corn). Cert. by NOFA. Serves whole state of Vermont.
Lakeland Organics/Bruenner Seeds Jess Niggeman & Ray Boughton E7110 830th Ave. Colfax, WI 54730 715-962-4319	**Notes:** Organic corn seed.
Lancaster Ag Products 340 Beechdale Road Bird-in-Hand, PA 17042 717-293-9701	**Order:** call for information **Catalog:** call for information **Quantity:** wholesale **Notes:** Organic corn, soybeans, and forages.
Lawler Farm Center David Burns 206 S. Lincoln St. Lawler, IA 52154 888-388-3276	**Notes:** Organic seed and silage corn, soybeans, alfalfa, medium red clover, oats, barley, wheat buckwheat, flax, timothy.
Meadow Creek Enterprise Daryl Hinderman 130 North Ave., Box 445 Dickeyville, WI 53808 608-586-7564	**Notes:** Organic corn, alfalfa, oats, barley, clover, rye, and fescue.

Merit Seeds P.O. Box 205 Berlin, Oh 44610 800-553-4713	**Notes:** Organic corn seed.
Mighty Seed Seed International, Inc. 3208 Sue Circle Rio Rancho, NM 87124 505-892-7373 (505) 892-7301 e-mail: jckf777@aol.com	**Notes:** Certified organic seeds.
NC+ Organics 3820 North 56th Street P.O. Box 4739 Lincoln, NE 68504 800-279-7999 e-mail: organics@ncplus.com http://www.ncorganics.com	**Order:** on-line **Catalog:** check availability on-line **Quantity:** wholesale
NDSU Foundation Seedstocks P.O. Box 5051 Fargo, ND 58105 701-231-8140	**Order:** phone, pick-up **Notes:** Barley, durum, wheat, oats, flax, soybeans.
Bob Neevel 9838 50th Street SE Marion, ND 58466 701-669-2566	**Order:** phone, pick-up **Notes:** Soybeans.
Prairie Hybrids Seeds 27445 Hurd Road Deer Grove, IL 61243 800-368-0124	**Notes:** Organic corn seed.

Rohrer Seeds P.O. Box 250 Smoketown, PA 17576 717-299-2571 e-mail: info@rohrerseeds.com http://www.rohrerseeds.com	**Notes:** Organic corn seed.
Snow Seed Organic Division 21855 Rosehart Way Salinas, CA 93908 800-GRO-SEED e-mail: snowseedco@att.net	**Order:** phone, e-mail, pick up **Notes:** Vegetable, cover crop, feed and forage seeds. Many lettuces and other vegetable seeds.
< **Specialty Seeds, Inc./International Ag Labs** 1600 Railroad Ave. Albany, MN 56307 320-356-7689 800-685-4521	**Notes:** Organic corn, soybeans, and some alfalfa.
Superior Organic Grains N 7076 Hwy. C Seymour, WI 54165 920-833-6953 Fax: 920-833-2751 e-mail: superiororganics@aol.com	**Order:** phone, fax **Catalog:** print **Quantity:** wholesale **Notes:** Soy, winter rye, winter wheat, birdsfoot trefoil certified organic by OCIA International.
Timeless Seeds, Inc. 120 4th Avenue SE Conrad, MT 59425 406-271-5770 e-mail: dave@timeless-seeds.com http://www.timeless-seeds.com	**Order:** e-mail **Catalog:** on-line, print **Quantity:** wholesale **Notes:** Pulse, cereal, specialty crops.

Wayne & Ryan Wangsness 1869 Middle Ossian Road Decorah, IA 52101 319-532-9431	**Notes:** Certified organic oats.
Wehrmann Grain & Seed Ltd. RR #1 Ripley, Ontario N0G 2R0 Canada 519-395-3126 Fax: 519-395-2935 e-mail: ingasven@hurontel.on.ca	**Notes:** Soybeans, wheat, oats, rye, covercrops, spelt, and other field crops. Ask for organic.
Welter Seed and Honey Co. 17724 Hwy. 136 Onslow, IA 52321-7549 800-728-8450 800-470-3325	**Notes:** Organic corn, soybeans, alfalfa, clover, timothy, oats, barley, triticale, buckwheat, peas, rye, wheat, ryegrass, vetch.

Table 2. Suppliers of Certified Organic Seed for Horticultural Crops.

Common Ground Farm 176 Zuck Road Spring Mills, PA 16875 814-364-9171 http://www.commongroundfarm.com	**Order:** see website **Catalog:** see website **Quantity:** wholesale, retail **Notes:** Organic vegetable seedlings, specializing in heirloom tomatoes.
Environmental Seed Producers P.O. Box 2709 Lompoc, CA 93438 805-735-8798 http://www.espseeds.com	**Order:** phone **Catalog:** on-line **Quantity:** wholesale **Notes:** Wildflower seed. Organic herb & flowers only.

FEDCO Seeds P.O. Box 520-A Waterville, ME 04903 Fax: 207-872-8317 http://www.fedcoseeds.com	**Order:** mail, fax (no phone orders!) **Catalog:** print (req. thru website or send $2.00) **Quantity:** retail/ wholesale **Notes:** Mainly wholesale seed co-op. Also Moose Tubers, Tree catalogs. Many organic vegetables, flowers, herbs & potatoes.
Filaree Farm 182 Conconully Hwy. Okanogan, WA 98840-9974 509-422-6940 e-mail: filaree@northcascades.net http://www.filareefarm.com	**Order:** on-line, phone **Catalog:** on-line, print **Quantity:** retail/wholesale **Notes:** Garlic and green manure seed. Certified Organic by Washington State Department of Agriculture.
Genesis Seeds Ltd. 800 S. Ocean Blvd. #LPH4 Boca Raton, FL 33432 561-391-8567 e-mail: mshemin@aol.com http://www.genesisseeds.com	**Order:** e-mail, on-line (with credit card) **Notes:** Vegetables, flowers, herbs.
Fred C. Gloeckner & Co. Inc. 600 Mamaroneck Avenue Harrison, NY 10528 914-698-2300 http://www.fredgloeckner.com	**Order:** see website **Catalog:** see website **Quantity:** retail **Notes:** Some organic flower plugs and some vegetables.

Harris Seeds Professional Growers Catalog P.O. Box 24966 Rochester, NY 14624 800-544-7938 http://www.harrisseeds.com	**Order:** on-line **Notes:** 1-oz. pkts. Limited selection of vegetable seed.
High Mowing Organic Seeds 813 Brook Road Walcott, VT 05860 802-888-1800 Fax: 802-888-8446 http://www.highmowingseeds.com	**Order:** on-line, mail, fax **Catalog:** on-line, print **Quantity:** retail **Notes:** Biodynamically grown, open-poll. seed for the Northeast.
Johnny's Select Seeds 955 Benton Avenue Winslow, ME 04901 800-854-2580 207-861-3900 800-738-6314 FAX e-mail: info@johnnyseeds.com http://www.johnnyseeds.com	**Order:** toll-free number, on-line **Notes:** Vegetables, flowers, herbs, cover crops.
Landis Valley Assoc. Heirloom Seed Project 2451 Kissel Hill Road Lancaster, PA 17601-4899 717-569-0401 Fax: 717-569-2147	**Order:** mail, fax **Catalog:** print **Quantity:** retail **Notes:** Single packets of heirloom varieties of the PA Dutch. Newsletter. Certified Organic by Pennsylvania Certified Organic Retail
Mapple Farm 129 Beech Hill Road Weldon, NB E4H 4N5 Canada e-mail: wingate@nbnet.nb.ca	**Catalog:** print **Notes:** Certified organic. OCIA-NB Producer #11051G029-90. Hardy, quick-growing cultivars for the North. Not recommended for US Southeast, Southwest, or any sub-tropical climate.

Mooarhill Farm and Greenhouses Mooar Hill Road RR 1 Box 5510 Mt. Vernon, ME 04352 207-293-2268 Fax: 207-293-4346 http://www.mooarhillfarm.com	**Order:** phone, fax **Catalog:** on-line, print **Quantity:** wholesale (organic seedlings), retail (herb & vegetable seed) **Notes:** Seedlings certified organic by MOFGA
Peaceful Valley Farm Supply PO Box 2209 Grass Valley, CA 95945 530-272-4769 888-784-1722 e-mail: (through website) http://www.groworganic.com	**Order:** phone or website **Catalog:** print or website **Quantity:** wholesale and retail **Notes:** Organic cover crops, vegetables, herbs, and flower seeds.
Rebecca's Garden 10601 Vista Road Columbia, MO 21044 410-531-5144 (phone/fax) e-mail: rebsorggarden@aol.com	**Order:** mail, phone **Catalog:** print **Quantity:** retail **Notes:** Offers one variety of organically certified tomato seed. Listed by OMRI 2002
Ronniger's Potato Farm Star Route Moyie Springs, ID 83845 208-267-7938 http://www.ronnigers.com	**Notes:** Organic potatoes, garlic, and onions.
Seeds of Change P.O. Box 15700 Santa Fe, NM 87506 888-762-7333 (orders) e-mail: gardener@seedsofchange.com http://www.seedsofchange.com	**Order:** on-line 5% discount, phone **Catalog:** on-line, print **Quantity:** retail/wholesale **Notes:** Flowers, herbs, vegetables, cover crops.

SeedWay 1225 Zeager Road Elizabethtown, PA 17022 800-952-7333 717-367-0387 e-mail: info@seedway.com http://www.seedway.com	**Order:** see website **Catalog:** see website **Quantity:** retail **Notes:** Flowers, herbs, vegetables, and cover crops.
SemTec/Nature Fresh P.O. Box 416 Center, CO 81125 719-754-2940 Fax: 719-754-2946 http://www.semtecseed.com **spudseed.com** 866-237-8733 Fax: 719-852-5146 Cell: 719-588-0490	**Order:** mail, phone, or fax **Catalog:** on-line **Notes:** spudseed.com is a marketing division of SemTec, which grows certified seed potatoes in the San Luis Valley of Colorado. This year some SemTec certified seed potatoes are also certified organic by the Colorado State Department of Agriculture, Organic Certification. Large quantities available for commercial growers. Also specialty potatoes.
Silver Seed Greenhouses P.O. Box 62 Bivalve, MD 21818 410-873-2943 e-mail: ubuubok@dmv.com	**Order:** contact for information **Catalog:** contact for information **Quantity:** wholesale **Notes:** Organic vegetable and herb plugs.
Terra Organics Maxwell, CA 541-942-9547 e-mail: seedgirl1@aol.com	**Notes:** Strictly wholesale.
Territorial Seed Co. P.O. Box 158 Cottage Grove, OR 97424 541-942-9547 Fax: 888-657-3131 e-mail: tertrl@territorial-seed.com www.territorial-seed.com	**Order:** mail, phone, toll-free fax, on-line **Catalog:** on-line, print **Quantity:** retail **Notes:** Some organic flowers, herbs, and vegetables.

Tinmouth Channel Farm Town Road 19 Wallingford Box 428 B Tinmouth, VT 05773 802-446-2812	**Order:** mail **Catalog:** print ($2.00) **Quantity:** retail/wholesale **Notes:** Certified Organic by OCIA. Over 1000 varieties of herbs. Wholesale suppliers of plants.
Wood Prairie Farm 49 Kinney Road Bridgewater, ME 04734 800-829-9765 800-631-8027 Fax: 800-300-6494 e-mail: jim@woodprairie.com http://www.woodprairie.com	**Order:**on-line, e-mail, fax, phone **Catalog:** on-line, print **Quantity:** retail **Notes:** Organic seed potatoes. Listed by OMRI 2002.

If your seed company offers certified organic seed and would like to be listed here, please contact Katherine Adam at kadam@ncat.org and provide the name of your certifier and the type of seed available.

Table 3. Suppliers of Untreated, Non-GMO Varieties, and Open-Pollinated Seed for Horticultural Crops—emphasis on small, alternative seed companies

Northeastern | Southern | North Central | Western | Canada

Northeastern Region

Butterbrooke Farm 78 Barry Road Oxford, CT 06478 203-888-2000	**Order:** mail **Catalog:** send SASE for seedlist **Quantity:** retail/wholesale **Notes:** Non-hybrid hardy vegetable strains raised by cooperating farmers.

The Cook's Garden P.O. Box 5010 Hodges, SC 29653-5010 800-457-9703 Fax: 800-457-9705 http://www.cooksgarden.com	**Order:** on-line, phone, mail **Catalog:** on-line, print **Quantity:** retail/wholesale **Notes:** Vegetable, flower, herb. *Trial gardens in VT; order center in SC.
Dirt Works 6 Dog Team Road New Haven, VT 05472 802-453-5373 e-mail: jfmeshma@dirtworks.net http://www.dirtworks.net	**Order:** e-mail, phone, mail **Catalog:** on-line **Quantity:** retail/ wholesale **Notes:** Grass seed for lawns, forages, and cover cropping.
Eastern Native Seed Conservancy P.O. Box 451 Great Barrington, MA 01230 Contact: Lawrence Davis-Hollander, Director 413-229-8316 e-mail: NatSeeds@aol.com http://www.enscseeds.org	**Order:** mail (see Web site for other procedures) **Catalog:** print, on-line **Notes:** non-profit seed exchange. Memberships: $25/$15 (low-income)/yr.
Heirloom Seeds P.O. Box 245 W. Elizabeth, PA 15088-0245 417-384-0852 (phone/fax) e-mail: via website http://www.heirloomseeds.com	**Order:** mail **Catalog:** on-line, print $1.00 **Quantity:** retail **Notes:** $1.00 refundable with order; free weekly internet newsletter.
John Scheepers Kitchen Garden Seeds 23 Tulip Drive Bantam, CT 06750 860-567-6086 http://www.kitchengardenseeds.com	**Order:** on-line, mail **Catalog:** on-line, print (free) **Quantity:** retail **Notes:** New company 2002. Vegetables and herbs.

Mooarhill Farm & Greenhouses Mooar Hill Road RR 1, Box 5510 Mt. Vernon, ME 04352 207-293-2268 Fax: 207-293-4346 http://www.mooarhillfarm.com	**Order:** mail, fax **Catalog:** on-line, print **Quantity:** retail **Notes:** Vegetable, herb seeds, most open-pollinated. (See Table 2 above)
New England Seed Co. 3580 Main Street, Bldg.10 Hartford, CT 06120 800-783-7891 860-724-1240 Fax: 860-724-1273 e-mail: newenglsee@aol.com http://www.neseed.com	**Order:** mail **Catalog:** request catalog on-line, or call **Quantity:** retail/wholesale **Notes:** Oldest US seed co.(pre-1800). Very large selection heirloom veg.
North Wind Organic Seeds	See High Mowing Seeds
Pepper Joe's 1650 Pembroke Road Norristown, PA 19403 Fax: 410-628-0507 e-mail: via website http://www.pepperjoe.com	**Order:** on-line, mail **Catalog:** on-line, print (send SASE) **Quantity:** retail **Notes:** Heirloom seeds. Free newsletter Chile News & Views.
Pinetree Garden Seeds P.O. Box 300 New Gloucester, ME 04260 207-926-3400 888-525-3337 (for orders) e-mail: superseeds@worldnet.att.net http://www.superseeds.com	**Order:** on-line, phone, mail **Catalog:** on-line, print **Quantity:** retail **Notes:** Free catalog. Specializes in packets sized for home gardeners.

Thompson & Morgan P.O. Box 1308 Jackson, NJ 08527 800-274-7333 Fax: 888-466-4769 e-mail: via website http://www.thompson-morgan.com	**Order:** on-line **Catalog:** on-line **Quantity:** retail/wholesale **Notes:** Separate catalogs for Internet, Internat'l/ commercial; print avail. only in UK; Lg. selection.
Turtle Tree Seeds Camphill Village Copake, NY 12516 518-329-3038	**Order:** mail **Catalog:** supplier list **Quantity:** retail **Notes:** Catalog specifies location/identity of supplier for each variety.
Southern Region	
Caudill Seed Company, Inc. 1201 Story Ave. Louisville, KY 40206-1791 502-583-4402	**Order:** mail **Catalog:** none **Quantity:** min 500 lbs. **Notes:** Agricultural field seed, beans reclamation seed and suppliers.
Christopher Weeks Peppers P.O. Box 3207 Kill Devil Hills, NC 27948 252-335-9353 e-mail: peppers@pinn.net	**Order:** mail **Catalog:** print **Quantity:**retail/ wholesale **Notes:** Large packs available; 10% discount orders over $20

Florida Mycology Research Center P.O. Box 18105 Pensacola, FL 32523 850-327-4378 e-mail: FMRC@webtv.net http://www.mushroomsfmrc.com	**Order:** mail **Catalog:** print **Quantity:** retail **Notes:** 5 sep. catalogs;$10 ea., or all 5 for $30.
Garden Medicinals and Culinaries P.O. Box 320 Earlysville, VA 22936 434-964-9113 434-973-8717 http://www.gardenmedicinals.com	**Order:** on-line, mail, phone, fax **Catalog:** on-line **Quantity:** retail/wholesale
Kilgore Seed Co. 1400 W. First St. Sanford, FL 32771 Fax: 407-323-6630	**Order:** mail **Catalog:** print ($1.00, refundable) **Quantity:** retail **Notes:** Primarily veg. Seeds for FL, Gulf Coast, sub-tropics, tropics.
Marianna's Heirloom Seeds 1955 CCC Road. Dickson, TN 37055 http://www.mariseeds.com	**Order:** on-line **Catalog:** on-line **Notes:** Tomatoes, peppers, plants.
The Pepper Gal P.O. Box 23006 Ft. Lauderdale, FL 33307-3306 954-537-5540 e-mail: peppergal@mindspring.com	**Order:** mail **Catalog:** seedlist **Quantity:** retail **Notes:** 200 varieties of hot, mild, and ornamental pepper seeds.

Seeds for the South 410 Whaley Pond Road Graniteville, SC 29829 Fax: 803-232-1119 e-mail: seedsout@mindspring.com http://www.seedsforthesouth.com	**Order:** on-line, mail **Catalog:** on-line, print **Quantity:** retail **Notes:** Heirloom seeds for the South
Southern Exposure Seed Exchange P.O. Box 460 Mineral, VA 23117 540-894-9480 Fax: 540-894-9481 e-mail: via website http://www.southernexposure.com	**Order:** mail **Catalog:** searchable catalog on-line, print **Quantity:** retail **Notes:** Print catalog $1.00 (U.S. customers) if requested through website; otherwise $2.00.
Thos. Jefferson Ctr. For Historic Plants P.O. Box 316 Monticello Charlottesville, VA 22902 804-984-9821 Fax: 804-984-0358 http://www.monticello.org/shop/	**Order:** on-line **Catalog:** on-line **Quantity:** retail **Notes:** Historic seeds, seed samplers, plants
Tomato Growers Supply Co P.O. Box 2237 Fort Myers, FL 33902 941-768-1119 888-478-7333 (orders) 888-768-3476 http://www.tomatogrowers.com	**Order:** mail, phone, fax **Catalog:** on-line, print **Quantity:** retail **Notes:** Heirloom tomato and pepper seeds.
North Central Region	

Baker Creek Heirloom Seeds 2278 Baker Creek Road Mansfield, MO 65704 417-924-8917 phone/fax e-mail: seeds@rareseeds.com http://www.rareseeds.com	**Order:** mail **Catalog:**on-line, print **Quantity:** retail **Notes:** Free catalog. Especially large selection of heirloom eggplant, melon, watermelon, and squash.
Borries Open Pollinated Seed Corn Farm 16293 E. 1400th Ave. Teutopolis, IL 62567 217-857-3377	**Order:** phone **Catalog:** info sheets **Quantity:** retail/ wholesale **Notes:** 4 varieties O-P field corn; cantaloupe, tomato.
Companion Plants 7247 N. Coolville Ridge Rd. Athens, OH 45701 740-592-4643 Fax: 740-593-3092 e-mail: complants@frognet.net http://www.Companionplants.com	**Order:** mail, phone, fax, e-mail, on-line **Catalog:** on-line, print ($3.00 for 56 p.) **Quantity:** retail **Notes:** Catalog states: "certified until 1995; without changing our practices, we have opted to forego certification due to expense and paperwork"
Cashton Farm Supply/CFS Specialties, Inc. 199 Front Street Cashton, WI 54619 608-654-5123 800-822-6671 Fax: 608-654-5696	**Order:** phone, fax **Catalog:** call for quotes **Quantity:** wholesale **Notes:** O-P seed corn, untreated seed corn, alfalfa, food grade soybean seed, custom seed cleaning. Other services for organic growers.

DeGiorgi Seed Co. 6011 N St. Omaha, NE 68117-1634 800-858-2580 402-731-3901 Fax: 402-731-8475 (fax) http://www.degiorgiseed.com	**Order**: mail, phone, fax **Catalog**: on-line, print **Quantity**: retail/wholesale **Notes**: Large selection of perennials, vegetables, grasses from US and Europe
Elixir Farm Botanicals General Delivery Brixey, MO 65618 417-261-2393 Fax: 417-261-2355 email: efb@aristotle.net http://www.elixirfarm.com	**Order:** on-line, phone **Catalog:** on-line, print **Quantity:** retail **Notes:** Biodynamically certified organic seed of native and Chinese medicinal plants.
Island Seed and Supply 19370 Hwy. G Mineral Point, WI 53565 608-776-3414	**Order:** mail, phone **Catalog:** no catalog **Quantity:** wholesale **Notes:** Primarily wholesale or direct to growers. Experimental, works with growers around US, esp. HI. Moving toward 100% organic.
Jon's Heirloom Plants PO Box 54 Mansfield, MO 65704 417-924-9733 e-mail: jon@jonsplants.com http://www.JonsPlants.com	**Order:** phone/mail **Catalog:** web **Quantity:** **Notes:** Heirloom vegetable/herb plants

Melissa's Seeds PO Box 242 Hastings, MN 55033	**Order:** mail **Catalog:** print **Quantity:** retail **Notes:** This is a start-up company by an 18 year old who lives on a pretty much self-sufficient farm with Mom and Dad and four brothers and sisters. Flowers, herbs, vegetables, books.
Mellinger's Inc. 2310 W. South Range Road North Lima, OH 44452 800-321-7444 330-549-9861 (orders) Fax: 330-549-3716 e-mail: mellgarden@aol.com http://www.mellingers.com	**Order:** mail, phone, on-line **Catalog:** on-line, print **Quantity:** retail/wholesale **Notes:**
Morgan County Wholesale 18761 Kelsay Road Barnett, MO 65011 573-378-2655	**Order:** mail, phone **Catalog:** print **Quantity:** retail/wholesale **Notes:** Vegetables, flowers. Supplies vendors at major farmers' market in NW Arkansas.
Prairie States Forage 54565 — 877 Road Wausa, NE 68786 402-373 -2514 402-373-4596 e-mail: Prairie@Bloomnet.com Contact: Brad Young	**Order:** phone **Catalog:** (contact above) **Quantity:** wholesale **Notes:** Uncommon types of annual and perennial forages for the Midwest and Plains states. Dealer for Barenbrug (Eur. Co.)

Revolution Seeds 204 North Waverly Street Homer, IL 61849 (217) 896-3267 e-mail: bodhi@prairienet.org	**Order:** mail **Catalog:** print **Quantity:** retail **Notes:** Garden seed—cucurbits, alliums, beans, sweet corn, peas, pepper, tomato, okra, greens, herbs, ornamentals. This is a 2004 start-up company with an interesting, entertaining catalog.
Sand Hill Preservation Center 1878 230th St. Calamus, IA 52729 563-246-2299 e-mail: sandhill@netins.net	**Order:** mail **Catalog:** print **Quantity:** retail **Notes:** Ships Jan. 1 to Aug. 15. Please, no calls on Sun., Mon., or after 9:45 p.m. Good selection of sweet potato varieties. Catalog includes poultry.
Seed Savers Exchange/ Heirloom Seeds/Gifts 3076 North Winne Road Decorah, IA 52101 319-382-5990, orders only (ph./fax) Fax: 319-382-5872 http://www.seedsavers.org	**Order:** on-line, phone, fax, mail **Catalog:** on-line, print **Quantity:** retail packets **Notes:** Retail branch of largest US seed exchange.
Underwood Gardens 1414 Zimmerman Road Woodstock, IL 60098 e-mail: info@underwoodgardens.com http://www.Underwoodgardens.com	**Order:** mail, e-mail, fax (no ph. sales) **Catalog:** print, on-line (searchable) **Quantity:** retail **Notes:** $3 for catalog.
Western Region	

Allen Kapular/Peace Seeds 2385 Thompson SE Corvallis, OR 97333 541-752-7421	**Order:** mail **Catalog:** 4 page seedlist **Quantity:** retail/wholesale **Notes:** Former research director of Seeds of Change has started up his former company again.
Bountiful Gardens 18001 Shafer Ranch Road Willits, CA 95490 707-459-6410 Fax: 707-459-1925 e-mail: bountiful@sonic.net http://www.bountifulgardens.org	**Order:** mail, phone,fax, e-mail **Catalog:**on-line, print **Quantity:** retail/wholesale **Notes:** Offers bio-intensive and Grow Bio-intensive seed. Rare grains, herbs, compost crops. European heirlooms. Affiliated with Ecology Action. Memberships $30/yr./basic rate. Rare Seeds Catalog $2.00.
Filaree Farm 182 Conconully Hwy Okanogan, WA 98840 509-422-6940 e-mail: filaree@northcascades.com http://www.filareefarm.com	**Order:** mail **Catalog:** print **Quantity:** retail/wholesale **Notes:** Garlic. Wholesale is by contract.
Fungi Perfecti P.O. Box 7634 Olympia, WA 98507 360-426-9292 Fax: 360-426-9377 http://www.fungi.com	**Order:** on-line, mail, fax **Catalog:** on-line, print **Quantity:** retail/wholesale **Notes:** Gourmet and medicinal mushroom technologies
Garden City Seeds P.O. Box 204 Thorp, WA 98946 509-964-7000 Fax: 800-964-9210	**Order:** mail, fax **Catalog:** on-line, print **Quantity:** retail/wholesale **Notes:** Flower and medicinal herb seeds for the Far North.

Hermosa Valley Garden Seeds P.O. Box 1409 Santa Maria, CA 93456 877-834-7333 Fax: 805-925-4140	**Order:** mail **Catalog:** print **Quantity:** retail/wholesale **Notes:** All seed untreated. Company founded 1998
High Altitude Gardens/ Seeds Trust 4150 Black Oak Drive Hailey, ID 83333 208-788-4363 208-788-3452 e-mail: mcdorman@seedsave.org http://www.seedsave.org, http://www.seedstrust.com	**Order:** on-line, mail **Catalog:** on-line, print **Quantity:** retail **Notes:** Specializes in varieties for high elevations/short seasons
Horizon Herbs P.O. Box 69 Williams, OR 97544 541-846-6704 Fax: 541-846-6233 e-mail: herbseed@chatlink.com http://www.chatlink.com/~herbseed/	**Order:** on-line, mail, phone, fax **Catalog:** on-line, print **Quantity:** retail/wholesale **Notes:** Plus store packets. Strictly Medicinal (R) line of herb seeds and plants.
Irish Eyes, Inc. P.O. Box 307 Thorp, WA 98926 509-964-7000 800-964-9210 e-mail: potatoes@irish-eyes.com http://www.irish-eyes.com	**Order:** on-line, mail **Catalog:** on-line, print **Quantity:** retail/wholesale **Notes:** Now a division of Garden City Seeds.

Mountain Valley Growers
38325 Pepperwood Road
Squaw Valley, CA 93675
559-338-2775
http://www.mountainvalleygrowers.com

Order: mail

Catalog: on-line

Quantity: retail/wholesale

Notes: 300 varieties herbs/perennials. Plants. 300 p. catalog free to U.S. growers.

The Natural Gardening Co.
P.O. Box 760776
Petaluma, CA 94975-0776
707-766-9303
Fax: 707-766-9747
e-mail: via website
http://www.naturalgardening.com

Order: mail

Catalog: on-line

Quantity: retail/wholesale

Notes:

Native Seeds/ SEARCH
526 N. 4th Ave
Tucson, AZ 85705
520-622-5561
Fax: 520-622-5591
e-mail: nss@azstarnet.com
http://www.nativeseeds.org

Order: fax, mail

Catalog: on-line, print

Quantity: retail

Notes: Non-profit org. with native/trad. Southwest seeds. Newsletter/publications. Seasonal catalogs.

Nichols Garden Nursery
1190 No. Pacific Hwy. NE
Albany, OR 97321
541-928-9280
866-408-4851
800-422-3985
Fax: 541-967-8406
e-mail: nichols@gardennursery.com
http://www.nicholsgardennursery.com

Order: on-line, mail, phone

Catalog: on-line, print

Quantity: retail/wholesale

Notes: Large selection herbs, unusual varieties, regionally adapted. Some organic, value-added products.

Organic Seed Alliance P.O. Box 772 930 Lawrence St. Port Townsend, WA 98368 360-385-7192 Fax: 360-385-7455 http://www.seedalliance.org	**Order:** mail, phone, fax, e-mail **Catalog:**on-line, print **Quantity:** retail/wholesale **Notes:** Non-profit public charity; $2 suggested donation for catalog. Seeds of the northwest Pacific Rim. Publishes newsletter Seed Midden. Not offering seed in 2004 due to fire that destroyed operations in August 2003.
Paradise Gardens Rare Plant Nursery RR 1, Box 488-B Bonners Ferry, ID 83805 Fax:253-981-1506 e-mail: paradisegds@yahoo.com	**Order:** mail, fax, e-mail **Catalog:** print **Quantity:** retail **Notes:** Catalog $2 (free to some plant soc. members), can't take credit cards. Mostly fragrant/rare/unusual perennials, but large stock of culinary herbs and gourmet vegetables.
Plants of the Southwest Agua Fria Road Route 6, Box 11A Santa Fe, NM 87501 800-788-7333 (orders) 505-471-2212 (cust. service) Fax: 505-438-8800 e-mail: via website http://www.plantsofthesouthwest.com	**Order:** on-line, phone, fax **Catalog:** on-line, print **Quantity:** retail/wholesale **Notes:** Website features 130 native wildflowers; also herbs, vegetables. Print catalog $1.00.
Redwood City Seed Co. P.O. Box 361 Redwood City, CA 94064 650-325-7333 http://www.batnet.com/rwc-seed	**Order:** mail only (no credit card, ph. orders) **Catalog:** on-line, free paper catalog **Quantity:** retail **Notes:** Native seeds, open-pollinated vegetables. Pamphlets. EcoSeeds (TM).

Sourcepoint Organic Seeds 1220 2640 Road Hotchkiss, CO 81419-9456 970-872-4941	**Order:** mail **Catalog:** seedlist $3.00 **Quantity:** retail **Notes:** Cereal grains, legumes, vegetables, herbs, fruit, flowers, and trees. Some seeds gathered from clean wild areas. Seeds raised in a "highly charged matrix of energies" in the Intermountain West.
Thunderfoot/Earthworks-Sow Organic Seeds P.O. Box 527 Eugene, OR 97544 888-709-7333 (orders) e-mail: organic@organicseed.com http://www.organicseed.com	**Order:** on-line, phone **Catalog:** on-line (no print catalog) **Quantity:** retail **Notes:** Recent merger. Primarily for Pacific NW.
Sunnyland Seeds P.O. Box 385 Paradox, CO 81429 970-859-7248	**Order:** mail **Catalog:** print **Quantity:** retail **Notes:** Native seeds of the Southwest.
Threshold Seeds Sowing Circle 95084 Cherry Ridge Lane Myrtle Point, OR 97458 541-572-3317	**Order:** seed exch. for biodynamic growers in Pacific NW only **Catalog:** no printed catalog **Quantity:** very small **Notes:** Apply for membership. Non-members try Turtle Tree Seeds. Seeds available after February 2002.

Victory Seed Co.
P.O. Box 192
Molalla, OR 97038
503-829-3126 phone/fax
e-mail:
safeseed@victoryseeds.com
http://www.victoryseeds.com

Order: on-line, mail

Catalog: print, on-line

Quantity: retail

Notes: Catalog $2.00. Newsletter.

Wild Garden Seed
P.O. Box 1509
Philomath, OR 97379
541-929-4068
http://www.wildgardenseed.com

Order: mail

Catalog: print

Quantity: retail/wholesale

Notes: Free catalog. Organically grown, open-pollinated farm-original varieties of many salad greens, vegetables, herbs and a few flowers.Will sell anywhere in the U.S. and southern Canada.

Canada

Belluz Farms
Kevin Belluz, Head Grower
RR #6, Candy Mountain Drive
Thunder Bay, Ontario, Canada
P7C 5N5
(866) 200-1011 (ph./FAX)
(807) 627-9080
e-mail: Kevin@belluzfarms.on.ca
http://wellrootedplants.com/

Order: contact for information

Catalog: contact for information

Quantity: retail

Notes: Suppliers of plants and plugs for North Central U.S. region—flowers, vegetables, grasses, and herbs. Sustainable greenhouse production.

Additional Seed Supplier Lists

MOSA Seed Suppliers
http://www.mosaorganic.org/seedsup.html

Notes: Seed suppliers in the Upper Midwest.

Organic Consumers Association http://www.organicconsumers.org/seeds.htm	**Notes:** State-by-state listing of suppliers of organic, heirloom, un-treated, open-pollinated, GE-free seed (mostly for gardeners).

References:

1) Doug Crabtree. 2003. E-mails to Nancy Matheson. 9/16/03. Elaboration and permission to quote 11/4/03.

By Katherine Adam and Nancy Matheson
NCAT Agriculture Specialists
March 2004

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IN THE CURRENT ISSUE

Goldfish:
Head to Tail
Knowing the basics of goldfish anatomy helps us recognize when there's something amiss

Koi & Goldfish Health:
How Deep Is Deep Enough?
There are no hard and fast rules, but your koi and goldfish will often fare the best in a pond that's as deep as you can comfortably make it

Well Planted Pond:
Sweet Flags
These hardy marginals add height and drama to the pond or the perennial border

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Water Gardens

by Neil Moran (moranneil@hotmail.com)

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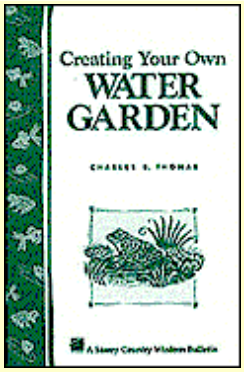
A frog leaps off the bank into a shallow pond just as a hummingbird pauses for nectar from a flaming red salvia plant. Meanwhile, water is splashing against jaded sandstone rock making it's way into the pool where fish swim just below the surface. A few feet away are two people taking it all in from their favorite summer perch.

For years now my wife and I have enjoyed the water garden that's the focal point of our front yard. We enjoy the sight and sound of water trickling between the statuesque plantings of delphinium, lupine and hollyhocks. And we enjoy watching the wildlife that frequent the pond like the frogs and hummingbirds.



Water gardening is one of the easiest forms of outdoor gardening; no hoeing, no weeding, no daily watering of transplants. And water gardening is one of the few things in life with which you will probably be more successful by doing less. The key is patience. The basics contained in this bulletin will get you started.

Water gardens have become a popular item for folks looking to add running water to their gardens and landscape. They're fairly easy to install and will last for years. They come in two styles: a hard shell prefabricated liner and a flexible liner. You can choose from a number of prefab liners that come in various shapes and sizes (up to about 8' X 10') to very large flexible liners. Prices range from $40 for a whiskey barrel type water garden to around $130 for a 5' X 6' prefabricated liner. Forty-five mil black flexible liners start at about $135 for a 10'X15' liner to $500 for the much larger liners. Whatever you do, don't settle for a cheap liner from a discount store. Purchase a quality liner, such as one manufactured by MacCourt or Tetra.

There are a few accessories you'll need to purchase to go with your liner including a pump, hose, fountain heads, and additives. And don't forget plants. A whole new world of gardening awaits you when you go searching for water lettuce, water hyacinths, lilies and prairie grass.

Before installing a water garden consider the overall location of your pond in relation to your house, deck, flower gardens or recreation areas where kids are playing. My wife installed a plastic prefabricated pond in the middle of what started out to be a small flower garden. The pond is located in the center of the front yard about ten feet in front of our deck. The deck, pond, flowers and trees blend in nicely to achieve the right effect.

Install your pond within reach of a garden hose and electrical supply for a pump and other accessories you may wish to add, such as patio lights. Avoid installing directly under trees where leaves will clutter the surface of the pond. Nearby trees also make for some difficult digging. However, if you must plant under trees, which is after all a natural setting for a pond, consider purchasing a light weight net to catch the leaves as they fall in the autumn.

Rocks are often used to add a natural look to a water garden. Here's where my wife used her imagination to create the effect she really desired, and you can too. You'll need a couple of wash tubs full of rocks to create a waterfall and to line the outside

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rim of your pond, should you choose to go with this type of design. Consult a local contractor to see what kind of rock is available in your area.

To achieve the waterfall effect, arrange the rock behind the pump (facing your viewing area) so that the pump hose can be slid just above the first layer of rock. It can be curved up behind four or five layers of rock and poke out through the second to last layer of rock. From there it can be wedged between two rocks and hidden from view. The water is then allowed to trickle down over the layers of rock. One problem with this design is that water can escape the pond as it splashes off the rock. This can be avoided by laying down a 40 mil black plastic piece of liner material under the first layer of rock, which will direct the water back into the pond.

Of course, there are simpler ways to achieve the trickling water effect. Fountain heads are inexpensive and simply sit atop the pump in the middle or off to the side of the pool. They send water shooting into the air, creating a mushroom type of effect. You can also attach the hose to ceramic frogs and turtles, which will "spit" water into the middle of the pond. As the old saying goes "you're only limited by your imagination."

Water pumps come in different sizes as well. Choose a pump based on how many gallons of water they pump per hour. A 300 gallon per hour pump is sufficient to circulate water in a 5' X 6' water garden and costs under $100. Seek the advice of a licensed electrician to install an electrical supply line that is safe and practical.

The prefabricated liners are easiest to install for the do-it-yourself homeowner. The flexible liners are a little more difficult, but not impossible to install yourself. If you do plan on installing a flexible liner you may want to watch the Hometime PBS series on water gardening to get a good idea on how to install one of these. You can purchase this video at major retail hardware stores.

Begin the installation of a prefab liner by outlining the shape of the pond with flexible water hose, spray paint or rope. Dig to the depth you need depending on the height of the pond you've purchased. Dig out the bottom of the hole as evenly as possible so your pond will be level. Level the rims of the pond by setting a liquid filled level over a flat 2X4. Take readings from 2 or 3 different angles. A pond that is not level will look awkward and should it overflow with water, it will dump its excess to one end of the pond, making that end quite soggy.

Now you're ready to fill the pond. The smallest prefab ponds and liners hold around 60 gallons. A 5' X 6' pond holds about 300 gallons. Incidentally, if done right you'll only have to drain and refill the pond at the beginning of each season. The introduction of plants and fish to the water garden is something that can be done a little each season.

Avoid the temptation to grow more plant life and fish than a pond can handle. What you're creating is an ecological balance between fish, plant life, insects and algae (this ecological balance is also what keeps your pond clean).

Less than half of your pond surface should be covered with plant life. This will allow you the opportunity to see fish swimming beneath the surface. Limit your fish to no more than a dozen per 4' x 4' section of pond area.

Water lilies, water lettuce and water hyacinths can be planted in the pond and are very attractive when in bloom. Some plants, such as water lilies, need to be rooted in containers seated at the bottom of the pond. Lilies are suitable for larger water gardens and spring fed ponds.

Bog plants, also known as emergent and marginal plants, include some hardy types such as pickerel weed, arrowheads, cattails and yellow water iris; and shorter species including golden-club, parrot's feather and spike rush. Bog plants root beneath the water or in the shallow water at the edges of the pond and grow skyward, projecting their pretty blooms to the heavens.

Goldfish, golden orfe, and different types of fantail fish do surprisingly well in a pond, once established. Before you add fish, test city water for chlorine dioxide and chloramine, both of which can be treated with chemicals purchased at a nursery or pet shop.

Allow your fish to adjust to the change in temperatures by placing bag and all into the water and leaving it a couple hours. The best time to do this is when the outside temperatures have warmed your pond. You may loose a few fish at first, thus its best not to invest too much in this aspect of your water garden project right away.

Fish will scavenge for insects and plant life in the pond but will also benefit from an occasional feeding of fish food. Avoid heavy feeding in the fall--fish don't digest food well in cool weather.

In warmer climates, fish can be left right in the pool over the winter. This may not be practical or desirable if the ice in the pond freezes right to the bottom! My wife places

a small heater in our pond, which prevents the pond from freezing over. You can also bring them inside to an aquarium.

Simply fill the aquarium with cold water and even some ice to avoid the shock of a sudden change of temperature, assuming this is being done late in the fall. Check the temperature before transferring your fish into the aquarium. Use your imagination when landscaping around your pond. Low growing plants are usually planted around the edge of the pond and between the rocks that line the pool, to conceal the rim of the liner. Pansies, petunias, dahlias, lilies and even small shrubs can be planted so they extend a few feet to several feet away from the actual pond. While you're at it, choose plants and shrubs such as *Scabiosa columbaria* (pink mist and butterfly blue), honeysuckle and salvia that will attract hummingbirds, butterflies and other wildlife to your water garden.

You're not done yet! You will need a comfortable bench or set of chairs to view your creation. Now sit back and enjoy your water garden.

Neil Moran is a Michigan author and co-owner of Haylake Gardens. Quality liners and equipment can be ordered from Haylake Gardens by calling 906-635-3556.

Neil Moran is a horticulture trades instructor and author of *North Country Gardening: Simple Secrets to Successful Gardening.* Neil is also the owner and operator of **Haylake Gardens**, a garden center and gift shop in the Upper Peninsula of Michigan. Questions and comments can be emailed to nmoran@30below.com.

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The Lure of the Back Yard Pool

by **Duane Plummer** (grdnlady00@aol.com)

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Eventually it happens to most gardeners.

"I think I'd like a little pool."

Then the hunt begins and for all the catalogs' assurances that their pools, liners, pumps and whatever are affordable, if you are like me, you gulp when you tally up what your whim is going to cost you.

Well, I'm here to tell you that it can be done inexpensively, and it needn't cost more than that last load of stuff you took out of the van when you stopped at the home center to see if anything new had come in. And of course it had.

I'm in Southwest Florida now, but I've gardened in more northern zones, too, and developed my "I'm not paying that much!" attitude a long time ago. This year I was able to start the way I had in Massachusetts years ago with a plain aqua, no ducky pictures, child's wading pool found for seven dollars at a Mart. (No, not the "W" one.) Small reflecting pools can be made successfully from black oil-changing pans sunk into the ground,too, but now we'll deal with a bigger pool.

Into the van it went. The pool in Massachusetts I'd sunk into the ground, but I did purchase square cement paving blocks to set this one on. I didn't feel like digging.

I set this up in my chosen place and said, "This needs something." I chose to put sand colored scalloped concrete border edgers against the outside pool edge and now only the lip shows on top. I'd put water in already to start dissipating the chlorine, for I knew a few inexpensive goldfish and some plants were coming. The border edgers can be omitted. That was my choice. The place I chose is under a small-leaved acacia tree, with a little direct sun on the water in the morning.

Remember, I'm in Florida. If I were to put my pool in full sun as is usually recommended, because it is shallow, my fish would be very unhappy and maybe not survive. (As it turned out, they didn't anyway because raccoons ate them, but we're not to that part yet.)

Because water lilies are expensive, I didn't start with them. I went to a garden store that stocks pool plants. Well, actually they didn't until I started bugging them. I bought water lettuce* from their own pond. A little bit of duck weed clung to it so I got a two-fer. A trip to an aquarium supply store got the goldfish, ten cents apiece, and a few floating oxyginating plants. I was on my way. The fish swam merrily about - they had so much *room.*

Bulbs for Fall Planting

- Tulips
- Daffodils
- Hyacinths
- Crocus
- Specialty Bulbs
- Amaryllis
- Alliums

Bulk Seeds for Fall Planting

Black-Eyed Susans

California Poppy Seeds
(25% Off)

Coreopsis Seeds

Blanketflower Seeds

Blue Lupine Seeds

Prairie Coneflower

White Yarrow

And they were so *visible.* It only took a couple of nights before Mama Raccoon and her kids found out where the raccoon equivelant of MickyD's was. They also chewed up my silk floating water lilies* that held my mosquito donuts out of sight. They even had the gall to chew open the fishfood container and eat the food! Their version of fries, of course.

War was declared! I bought some water hyacinths* only because I was afraid to go into ditches and snatch my own; (alligators and such, you know.) I, also, got and carefully cleaned off a bag of smooth round stones and lined the bottom. I added a few more fish. Lost some more to the Masked Bandits.

We learn by doing, so I had an "Aha!" We'd collected some nice rocks on our trip out west, so I stacked them artfully along the back and somewhat along the sides. (I realize a round pool doesn't have sides, but you know what I mean.) Now there were places for edging and bog plants. I also placed them in ways so that fish would have hiding places. It helped. We have three survivors. Three out of twenty isn't *great*, but.....

Gradually I added bog plants to rest on the rocks. My choices were star rush, horsetail reed, an arrowhead, and a dwarf cyperus. I found that an old pair of black or dark panty-hose cut in wide bands stretched around the tops of the pots and over the soil help hold it in should wind or a heavy rain bowl the pots over.

You have noticed I've said nothing about a circulating pump. A small pool, I've found, eventually finds its own balance. We did get some aquarium snails but I wouldn't have had to. Nature began supplying them. I put a few drops of algae buzz-off in at the beginning because I was impatient.

Raccoon interest seemed to dwindle as the surface plants began to spread and the fish could hide. We found some little native fish in a wet ditch and brought them home and added them. Whatever they are, the raccoons don't seem to care for them. They are peppy and school, even though tiny, and we enjoy them. (I hope they're not pirhanas.)

And as always happens, to my joy and amazement little frogs have found the pool to their liking, and it's fun to hear them plop into the water or see them sunning on lava rock from New Mexico. (If they only knew!)

A garden store that had too many tadpoles gave us some, and they made themselves right at home. They eat algae.

In the car, I keep small pots and a trowel in a cardboard box and I did dig some native plants from wet ditches for bog plants. One of my digging rules is to not take the only one of its kind from an area, unless bulldozers are closing in. I check to make certain there are others to seed and keep the race going.

A word about natives. If you can find them, use them. Don't put in tadpoles from another part of the country. They are not indigenous and can eventually mess up the eco-system as can any non-natives.

Now for all of those ***s. Neither water lettuce or water hyacinths may be *shipped* to Florida. The rule here is, if they overgrow your pond, throw the excess onto your compost pile. *Never* put any water plant or non-native fish into your local waterways. You can have problems up north, too. Where I lived in up-state New York someone got the bright idea of growing water chestnuts in a pond as a crop. Not only weren't they the edible ones, they have escaped into the Mohawk River and are a giant problem.

For the last *: I got mad when the raccoons destroyed the silk water lilies I'd paid ten dollars apiece for. I went to a discount store and bought a bunch of large silk flowers for a dollar. With wire cutters, I made three separate stems. Then I took a green plastic foam tray from the produce department and cut three circles large enough to float, but small enough to hide under each blossom and leaf group. I jammed the stems of each through the plastic, and on one through a mosquito donut, and voila! New "lilies" for a dollar! Tucked among the water hyacinth's full leaves, they look very realistic.

We're happy with our pool. Potted plants sit around the edge to further soften it, cardinals perch on the rocks to get drinks, dragonflies skim over it, fish swim in it, tadpoles are maturing in it, frogs plop into it. And the snails.....boy, they really mulitiply!

ChamomileTimes.com

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Mirrors: fishbase.org | fishbase.de | fishbase.fr | fishbase.se | fishbase.tw

English | Spanish | Portuguese | French | German | Italian | Dutch | Chinese **More languages...**

FishBase

(28500 Species, 193900 Common names, 36700 Pictures, 33700 References, 1110 Collaborators, 11 million Hits/month)

(06/2004)

Common Name

contains [ ] Search (e.g. rainbow trout)

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

中文 العربية Русский 日本語 हिन्दी Ελληνικα **More scripts...**

Scientific Name

Genus is [ ] Search (e.g. Rhincodon)

Species is [ ] (e.g. typus)

◉ Summary ○ Eschmeyer (Species) ○ Eschmeyer (Genera)

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

To search without Genus, change Genus option from "is" to "contains".

Glossary

[ ] Search (e.g. oophagy)

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Information by Family

[ ] [ ]

○ Family info.	○ Pictures	○ References (FishBase)	○ Missing photos
○ All fishes	○ Identification	○ References (Eschmeyer)	○ Stamps
○ Nominal species	○ Identification keys		○ Graphs

Note: Lists may be incomplete. Some lists may be very long and will take time to load.

Information by Country / Island

[ ]

Biodiversity	Uses	Tools	Miscellaneous
○ All fishes	○ Commercial	○ Identification keys	○ Country info
○ Freshwater	○ Aquaculture	○ Field guide	○ FAO profile
○ Marine	○ Aquarium trade	○ Occurrences	○ ReefBase profile
○ Introduced	○ Game fishes	○ Type localities	○ Treaties & Conv.
○ Endemic	○ FAO aquaculture	○ References	○ Collaborators
○ Threatened	○ FAO catches	○ Missing data	○ Fish stamps
○ Dangerous	○ ICES catch	○ Missing photos	○ Common names
○ Reef-associated	○ Fish Loss	○ Ecopath data	○ Public aquariums
○ Pelagic			○ Spawning aggregation
○ Deep-water			

Note: Lists may be incomplete. Some lists may be very long and will take time to load.

Information by Ecosystem

[ ]

- All fishes
- Ecosystem info
- Trophic pyramids
- Ecopath parameters
- Point data
- Resilience of fishes

Note: Lists may be incomplete. Some lists may be very long and will take time to load.

Information by Topic

Trophic ecology
- Diet
- Food items
- Food consumption
- Ration
- Predators

Physiology/Behavior
- Metabolism
- Gill area
- Brains
- Vision
- Fish sounds
- Swim. speed

Life history
- Growth
- L-W relationship
- Length frequencies
- Recruitment
- Reproduction
- Maturity
- Spawning
- Eggs
- Egg dev.
- Larvae
- Larval dynamics

Uses
- Aquaculture
- Aquaculture profiles
- Introductions
- Diseases
- Ciguatera
- Processing
- Ecotoxicology

Genetics
- Genetics
- Allele frequencies
- Heritability

Miscellaneous
- Treaties & Conv.
- CITES
- National databases
- Names by language
- Collaborators
- Public aquariums
- Expeditions
- Video
- Fish stamps

Note: Lists may be incomplete. Some lists may be very long and will take time to load.

Tools

- Identification
- Identification keys
- Adverse introductions
- Global introductions
- Species by ecosystem
- Graphs
- Match names
- Disease diagnosis
- My Fish Page
- Life-history tool
- L-F Analysis
- ISSCAAP Troph
- FAO aquaculture
- FAO catches
- Catch analysis
- ICES catch
- Fish statistics
- World records
- Fish collections
- Trophic pyramids
- Ecopath parameters
- New species
- New photos
- Web Stats
- Top 100

Note: Tools without radio button are available from the Species Summary page.

Biodiversity Maps

- Collection sites
- Collection sites by 1-degree EAG
- Species by climate zone
- Collection points
- Collection History
- Collection sites by 2-degreee EAG
- Species by FAO area
- Collection records by museum
- Collection sites by 10-degree EAG
- Families by FAO area
- Occurrence records by record type
- Before and after map
- Commercial species by FAO area

(loading may take 2-4 mins.)

Note: EAG = Equal Area Grids

References

Author [ ] Search (e.g. Randall)

FishBase A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Eschmeyer A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Year [ ]

Title [ ] (e.g. Gilbert Islands)

Source [ ]

RefNo [ ] (e.g. 32 or 32, 123, 2700)

Fish Journals ICES papers

- FishBase
- Eschmeyer
- Bibliga

Note: Use the TITLE field to search for keywords in the Bibliga database.

References Citing FishBase

How to cite FishBase
To give due credit to the original authors, please cite data taken from FishBase by Main Ref. and/or Data Ref. of the respective record.

Cite FishBase itself as
Froese, R. and D. Pauly. Editors. 2004. FishBase.
World Wide Web electronic publication.
www.fishbase.org, version (06/2004).

Note: FishBase is also available on CD-ROM, with detailed information on population dynamics, genetics, morphology, trophic ecology, physiology, ecotoxicology, reproduction, etc. See the FishBase homepage or the FishBase book for more information. FishBase was assembled with the help of many partners and with the support of the European Commission and other sponsors. Contact us if you want to provide pictures, data or reprints."

Page created by: Eli, 07.10.03, last modified by Eli, 07.07.04

Organic UK

Growing
Start here
Sq. Ft. Gardens
Urban farming
Garden tour
Links
Food

HOME

IN ASSOCIATION WITH amazon.co.uk

ethical junction member

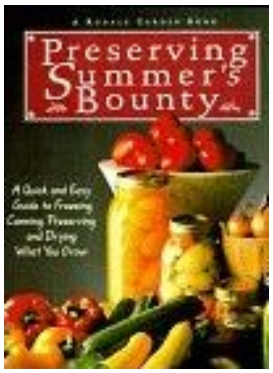
Welcome

Organic UK is pesticide & GM free! The site is 'not for profit' and offers independent advice and support for UK organic gardeners.

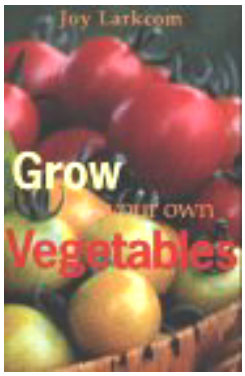
Soil remineralisation project - read about this important new project.

The Organic UK Forum - a friendly and welcoming place for all your organic gardening queries and suggestions.

From the Bookshop - August



Now it is the season of 'the glut' it is time to think about preserving your harvest. This is a superb, practical book which gives vital information about the best way to preserve fruit and vegetables.



This is probably THE best veg growing book around. It is packed full of practical information for beginners and experienced gardeners.

OGUK Bookshop

OGUK Forum NEW!

Selected Links

Kitchen Gardeners International (KGI) is a new non-profit network whose mission is to celebrate homegrown, home-prepared foods in their many international forms and to promote their role in building a healthier, tastier, and more sustainable food system. Click on the image (left) to go to their site.

Site Updates

August 2004
The soil remineralisation page has been updated

<<< Go to the latest new pages

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Site Info

The Good Gardeners Association is a UK charity promoting links between healthy soil and healthy and nutritious food. Their site is worth a look and anybody interested in organic gardening should consider joining - its not expensive! Click on the image (left) to go to their site.

Why grow your own food?
"There is no act more gratifying, more basic, more liberating, than to coax food from the Earth. Time and the rhythms of nature become the ultimate template by which to live. Do it just to know that you can do it, or do it just to live or do it to save money or for whatever reason. You want to talk about an essentially useful skill-set? Learn how to grow some or most of your own food."
From: www.verdant.net/food.htm

The Bikes page

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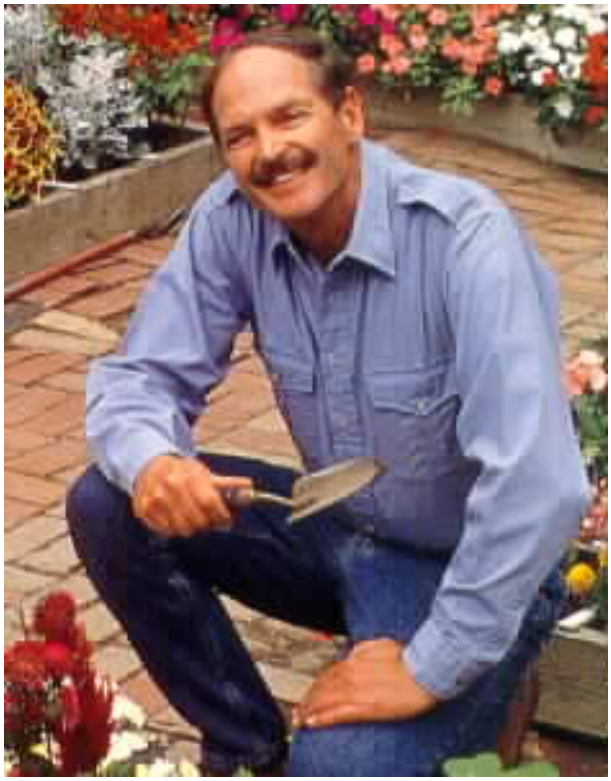


The easy and rewarding gardening system

Listen to the Square Foot Gardening Theme from TV and The Tapes

Midi developed by Jim van Voorheis, Stuart Florida

****

Due to computer failure and other problems I lost many of the segments that were on the Square Foot page. As I develop them back in a better style they shall appear. Please send me any Ideas you

have or would like to see. Just click below to email me.

Things we did have were: List of states, a weekly chat, links to other sqft pages and seed companies and sq meter gardening which all those pages were lost.

IF YOU DON'T BACK UP! DO IT NOW!

Farmer Brown

Here is my new garden. Just flowers and no bending over

My visit with Mel

I was able to meet and have lunch with Mel as he is writing and working on getting all his many pictures in order down here in Florida. It was a thrill to see him again since he spoke about Square Foot Gardening a few years ago in West Palm Beach.

****

The SQFT List

Here are the directions to get on the a computer email system to correspond with other Square Foot Gardeners around the world.

To join the newest sqft list go to Coollist.com. Click on "Join a new mailing list"Under "List ID" put in sqft your email address. You will need to fill out some other information and you will be ready to let us hear about your garden.

Search all the old messages from the beginning in 1997 at:

www.hort.net/lists//sqft/

****

Square Foot Gardening Chat

It's back again, the SqFt Chat. Want to chat and compare notes on your garden? Lets Chat.

Click below which will take you to the chat room. There is no set time so it is best to set up a chat with someone on the Square Foot List (above) and meet then. When you click below it will open up an applet in a few seconds, you enter your nickname, profile (if you want) and start to chat.

Enter the chat room here!

Visit Bravenet.com who supplies this chat room.

****

Square Foot Garden Message Board

If you would like to tell us about your garden , make a comment about Square Foot Gardening or any Questions you want to ask and have others answer join in. Bookmark the page so you can return often. This is the Garden Web, Square Foot Gardening Forum.

****

You can get the latest copy of the News-e-Mail by clicking on Mel's page in the upper right hand corner.

****

Square Foot Gardening in the UK

Or

Another Great Site

For our gardening friends in the United Kingdom please look here.

**********8

The Square Foot Gardening Club

Here you can ask questions, give your advice and even have a chat with other Square Foot Gardeners, stop in and visit.

****

Check out using Square Foot Gardening in the Landscape

By Patrick J. Prickett

****

Square Foot Gardening Software

Garden Manager 3.0

This is it, Software for our Square Foot Garden. Jonathan Maier has developed this program to help keep our gardens organized. Garden Manager 3.0 for Windows 95/98 is shareware, you can download it from and see some of the screenshots at http://www.mindspring.com/~jmaier/garden/ When you use the program you can register it for $15.00. Jonathan has put in time and effort so give it a try and register it if you use it. You can contact Jonathan Here.

Square Foot Gardening Books, Tapes, Shirts and Caps

If you want you can get the book and tapes from Mel: click here Now you can get the New Square Foot Gardening Caps and T Shirts.

Schools and SqFt Gardening

A Square Yard In Your School Yard

The Square Foot Foundation's Project Number 6 is A Square Yard in Your School Yard . This is of special interest to teachers. Drop in and get a copy of the teachers guide to Square Foot Gardening.

I if you have comments or things you would like to see added to the Square Foot Pages please email me.

Return to the SqFt Path

Below is the Text of the Teachers Guide By Lila Ralston and Catherine Little

A SQUARE YARD IN THE SCHOOL YARD

TEACHER'S KIT

For more Square Foot Information after you read this Guide click here

We welcome you and your students to Square Foot Gardening. This kit is designed for those with no gardening experience at all; experienced gardeners may already know much of this material.

A WORD ABOUT GARDENING METHODS

Gardeners, and especially gardening authorities, have a strange tendency to sound as if they have discovered the One True Way. Please take this with a grain of salt. This guide is based on Mel Bartholomew's Square Foot Gardening, a book and method we feel is well-suited to school garden projects. This does not mean there is no other source of useful garden information. If you see information that conflicts with what you read here, don't worry. There are many ways to garden; experiment with new ideas and different ways of doing things. From time to time you will need detailed information on varieties of plants, pest control, composting, etc. There are many excellent books and magazines on the market and in your local library. We regard their authors as colleagues, not competitors. If two authors disagree about the best way to do something, try both methods and see which works best for you (an excellent science activity!).

Contents

What is the Square Foot Method?

Glossary

How to Start Your Square Foot Garden

Garden layout

Deciding what to plant

When to plant

Seed starting vs. transplants

Caring for your garden

Spacing recommendations

Tips to Remember

Soil

Spacing

Water

Weeds, pests and diseases

Plants Recommended for Beginners

What to Grow if your Garden is Too (Something)

Sources for seeds adapted to specific areas

Curriculum Suggestions

Diagrams --- hit your back button to get back here from the Diagram.

Construction of block frame

Construction of square foot dividers

Construction of raised bed frame

Wheel chair garden

Construction of trellis

Soil preparation procedure

WHAT IS THE SQUARE FOOT METHOD?

Square foot gardening is a method that sets plants in a grid pattern rather than in rows with spaces left between. The basic unit is a block, three feet by three feet or four feet by four feet, that is further divided into one-foot squares. Each block is surrounded by paths on all four sides. The gardener steps only on the paths, so the soil does not become packed down.

Because plants are spaced closer together in the square foot method, the condition of the soil is especially important. It must be deep, loose, and well-cultivated, with plenty of organic matter to provide nutrients and allow air and water to reach the plants' roots.

When a square is harvested, new seeds or transplants are planted immediately. This allows for steady production throughout the season, maximizing your harvest. A square may contain from one to sixteen plants, depending on each crop's requirements; a chart of suggested spacings for common plants is included in this kit.

GLOSSARY

Annual: A plant that completes its life cycle, from seedling to seed-producing maturity, in one year.

Biennial: A plant that takes two years to grow from a seedling to maturity.

Block: As used in SFG, a square area of garden small enough that all parts can be reached comfortably without stepping or leaning on the soil. Gardens for adults and older children are based on four-foot by four-foot blocks; those for younger children, on three-foot by three-foot blocks.

Compost: Organic matter that has been broken down by the action of bacteria, fungi, and other organisms. It contains some nutrients, but its most important effect on your garden is to improve

the texture of your soil and allow it to hold more air and water.

Cubic Foot: A volume equal to a cube 1 foot wide by 1 foot high by 1 foot deep. Also equals about 7 1/2 gallons.

Diatomaceous Earth: A powder made of the glassy skeletons of diatoms (microscopic marine organisms), d.e. is used to kill or repel slugs and insects. Although d.e. has millions of microscopic spikes that can pierce an insect's shell, it is harmless to humans; it has even been used as an abrasive in toothpaste! Be careful not to breathe it, though; like any dustlike substance, it can irritate your respiratory system.

Direct Seeding: Planting seeds directly in the place you want the plant to grow, as opposed to starting them in one place and transplanting them later.

Fork: A garden fork, a four-tined implement used for loosening soil.

Mulch: Any material used to cover the soil surface. Mulch prevents weeds from sprouting, retains moisture, and helps keep the soil moist. It can also insulate the soil, keeping it cool in hot weather. Don't put on mulch too early in the spring; it keeps the soil from warming up. Possible materials for mulch are hay, pine straw, layers of newspaper, old carpet, plastic sheeting, etc.

Organic Matter: Decayed or partially decayed remains of plants or animals. Except for manure, blood meal and bone meal, don't use animal products, e.g. meat scraps, in your garden or compost. Also, do not use dog or cat droppings; they are a disease and parasite hazard.

Peat moss: Dried sphagnum moss, a bog plant. Peat moss is an excellent source of organic matter to add to your soil.

Perennial: A plant that will live for more than two years, producing seeds each year. Some plants, such as tomatoes, are perennials in their native habitat but are treated as annuals in temperate climates because they can't survive the winter.

Raised Beds: Essentially, large bottomless containers filled with soil that rest on the ground. If your soil is rocky, very infertile, or poorly drained, you can make your blocks into raised beds by building the frame 12 inches or more deep (see diagram).

Seed Starting: Growing transplants for later planting in the garden.

Seedlings: Plants that have recently sprouted from seeds. When they are big enough to move out to the garden, they're called transplants.

Spade: A shovel with a flat blade and a square tip. Preferable (for Square Foot Gardening) to a curved shovel with a pointed tip because it allows you to dig a straight-sided, flat-bottomed hole.

Square: As used in SFG, a one-square-foot portion of your garden.

Tiller: A powered garden machine for cultivating soil. In your Square Foot Garden you will need a tiller for one day a year at most. Rent or borrow one, or use a spade and fork instead.

Transplants: Young plants that are ready to be moved out into the garden. You can purchase transplants or, if you have a suitable location, start your own from seed in the late winter or early

spring.

Trowel: A hand implement for digging. If you can bend a trowel, it's no good. This is the tool you will use the most; try to get a good sturdy one.

Vermiculite: A form of the mineral mica that has been heated until it expands (similar to the way popcorn pops). Vermiculite is extremely light and can hold water like a sponge. It does not decompose so it lasts many years in the garden.

HOW TO START YOUR SQUARE FOOT GARDEN

Garden Layout

In selecting a location for your garden, try to choose a spot that is reasonably level, receives at least six to eight hours of sun per day, has decent soil, is well drained, and is convenient to your classroom and to a water source. Do not locate your garden in a depression or at the foot of a slope; you will have drainage problems (and frost problems, if you live where there is frost). If you must choose between several sites, remember that the condition of the soil is the easiest of these factors to change.

Once you have chosen your site, make a frame to mark off the garden area and contain the growing soil. We recommend a frame of 2x4 or 2x6 lumber, which can often be obtained free from contractors who have some left over. Make the frame 3 feet by 3 feet for young children (up through fifth grade); 4 feet by 4 feet for older children and adults. This ensures that the gardeners can reach all parts of the block easily.

Next, mark off the area where the frame will be placed. Remove the sod and compost it. Cultivate the soil to loosen it to a depth of 12 inches or more. You may want to rent or borrow a tiller, or use a heavy-duty spade and fork. This initial cultivation may be hard work, but it only has to be done once. (In subsequent seasons you will only need to loosen the already-cultivated soil; a fork or a spade and fork will work nicely for this.)

After loosening the soil, assemble your wood frame. Then put in 4 cubic feet of Mel's Mix: equal parts of vermiculite, compost and peat moss. (Coarse vermiculite is preferable to fine vermiculite; nurseries often sell the coarse grade in 4 cu.ft. packages, which are much cheaper than the smaller packages you find elsewhere.) Work this into the soil thoroughly, being sure to break up any clods and remove rocks, sticks and other debris.

Your block will need paths around the outside (at least two feet wide). Paths may be made of lumber, wood chips, gravel, grass (which must be mowed), or any other material that will keep your feet clean and will look tidy. You will also need some kind of divider to make a clear division between the individual one-foot squares. A rigid frame made of 1/4" by 3/4" wood strips connected by bolts works well. Paint it white so it will last longer and show up better. This will really make the square-foot organization clear and will give you a visually stunning garden. Other possibilities for the dividers are vinyl-coated clothesl ine stapled or nailed to the frame of the block; and bamboo poles lashed together (in areas where bamboo grows, you can often get it free). If you can't get the specific materials mentioned here, scout your area for workable substitutes. The main things to keep in mind are plenty of organic matter for your soil; a sturdy border around each block; clean, uncluttered paths; and neat, clearly visible dividers to mark off individual square feet.

Once you have your garden set up, you will need a supply of compost for use throughout the growing season. Each time you harvest and replace a plant, you'll add compost to keep the soil from becoming exhausted. Compost is expensive to buy but easy to make: if you don't have a compost bin or pile, start one!

During the gardening season, the only tools you will need are a trowel, a bucket, and a cup. You'll be using the bucket to carry water, so be sure it's not too heavy to carry when full. Extra buckets and trowels are helpful if many people will be gardening at the same time.

Deciding What to Plant

When deciding what to plant in each square foot, keep the following in mind. First, the quantity you plant should depend on how much you want to harvest and when (all at once or over an extended period). Second, don't let tall crops block the sun from reaching shorter ones (unless the shorter crop needs shade). Third, if you are growing large plants such as corn, melons, or tomatoes, look for smaller, more compact varieties. These are especially well suited to the square foot garden.

These considerations, plus figuring out the time between planting and harvest, how many plants of a given kind will fit in a given space, and which side of the garden the sunlight is coming from, will provide your students practice in math, geometry, and conflict resolution! If possible, assign each child his or her own square foot. If necessary, a team of children can share a square, or children can grow fast-maturing crops and garden in relays. We have included more detailed curriculum ideas at the end of this guide.

When to Plant

Consult your local extension agent for the date of your average last spring frost. Planting recommendations on seed packets, in catalogs, and in garden books and magazines are based on this date (and/or on the date of your first autumn frost).

Seed Starting vs. Transplants

The fact that the school year ends just as the gardening season reaches full swing poses a special problem for school gardeners. Using purchased transplants can enable you to harvest some crops before school ends even in the northern zones of the U.S. Still, seed starting gives children (and adults!) a particular sense of accomplishment. If you have suitable indoor space and lighting, we recommend starting at least some of your plants from seed. In addition, try some fast-growing crops that can be direct-seeded outdoors, such as peas and beans.

If you need transplants but your budget is inadequate to buy them, ask for volunteers who can start seeds at home for you during the winter. This makes a good project for a child to report on in class; it may also interest parents in helping with your garden project in other ways.

Although seeds are less expensive than transplants (for the same number of plants), seed prices can vary widely. It pays to look at several catalogs and retail sources to find the best price for the seeds you want. In some parts of the country, hardware stores sell seeds of non-patented varieties (usually "old standards" that have been popular for many years) for ten cents a packet or less. Be sure they are dated for the current year! Some seeds lose viability rapidly and last year's seeds may

not be a bargain at any price.

Caring for Your Garden

Caring for your garden involves three main tasks: watering, pest control, and harvesting. The most important factor for success in all three tasks is frequent, careful observation of your garden. If you inspect each square carefully every day (or at least every school day), you can water the plants before they suffer from drought stress; you can spot pest problems before they get out of hand; and you can harvest your crops at their best. Putting off any of these tasks for a week or two can invite disaster. Withered seedlings, insect-riddled leaves, and mushy, dachshund-sized zucchini will certainly make an impression on your students, but not a pleasant one.

Water your plants by pouring water from a cup onto the soil at the base of the plant; not on the leaves. Wet leaves are vulnerable to disease, and besides, it's the roots that need the water. Do not overwater! If the soil is still damp, wait until it is dry an inch or two below the surface before watering again. Likewise, be sure you water deeply enough to dampen the soil several inches below the surface. Watering too shallowly will encourage your plants to form roots mainly at the surface, which will make them vulnerable to drought.

Pest control: if you see an insect in your garden, observe it to see if it's damaging your plants. Most insects are beneficial, acting as pollinators or preying on pests. Caterpillars and slugs are two exceptions to this rule; they're easy to identify and they'll eat you out of house and home. Pick them off and get rid of them. We do not recommend using chemical pesticides, especially with young gardeners. If hand-picking pests doesn't take care of the problem, try one of the organic pest-control products such as diatomaceous earth.

Harvesting: If you are not an experienced gardener, consult gardening or cooking magazines or books for advice on when to harvest the crops you are growing. Many crops, such as lettuce, can be harvested at almost any stage during their growth; others, such as peas, have a fairly narrow "window of opportunity" during which they are at their best. This is also useful information to have when you buy produce grown by someone else!

The off-season: If it's not possible for someone to tend your garden during the summer, you can either mulch it heavily with something that will decompose (like shredded leaves), or plant a cover crop (like clover, buckwheat, alfalfa or vetch). Either of these will keep the soil from compacting and add organic matter while keeping down weeds. If someone can check on the garden periodically you could try growing a low-maintenance crop like squash, pumpkins, ornamental corn or popcorn. This will give you something to look forward to in the fall!

Spacing Recommendations

Here are some spacing recommendations for a basic Square Foot Garden. For information on growing plants on trellises, in trenches, or under frost protection, consult Square Foot Gardening or "Ten New Square Foot Garden secrets" in Organic Gardening, February 1996.

One plant per square foot (12 inches apart): peppers, "patio" (dwarf bush) tomatoes, potatoes, broccoli, cabbage, cauliflower, kale, head lettuce, New Zealand spinach, peppers, peanuts, potatoes, large sunflowers, tampala (amaranth)

Four plants per square foot (6 inches apart): leaf lettuce, parsley, Swiss chard, sweet corn (small varieties), mustard greens, basil, coriander, dill, parsnips, shallots, small sunflowers, turnips

Nine plants per square foot (4 inches apart): bush beans, spinach, leeks, anise, chervil, corn salad (mache), mustard greens, nasturtiums

Sixteen plants per square foot (3 inches apart): carrots, beets, radishes, onions, cumin, garden cress

For plants not on this list, look on the seed packet and find the recommended spacing after thinning. Ignore the space called for between rows. For example, if the directions say "Thin to six inches apart in rows two feet apart," space plants six inches apart in every direction, i.e., four per square foot.

TIPS TO REMEMBER

1. Soil. Soil must be loose-textured, at least 12 inches deep (more is better) with plenty of organic matter.
    . Never, ever step on your soil! Walk, stand, sit and lean only on the paths.
    b. Do not depend only on packaged fertilizers (organic or synthetic) to nourish your plants. Organic matter is critical to your soil's water- and air-holding capacity. Work in PLENTY of it when you first dig your garden, and add more every time you replace the plant(s) in a square.
    c. Don't work your soil when it's wet. It will become mud and the air spaces will disappear permanently.
2. Spacing. Square foot gardening is based on efficient spacing of plants with no wasted area.
    . Don't plant more than you need! Base the size of your garden on how much of each crop you actually want, not how many seeds or how much land you have.
    b. Try growing large crops vertically. Vining tomatoes, zucchini, cantaloupes, and other large, sprawling plants do very well when trained up a trellis.
3. Water. Because a square foot garden is small and compact, elaborate sprinkler systems are unnecessary. You can water your entire garden with only a bucket and a cup.
    . Let water stand in the sun until it is warmed (this also allows chlorine to evaporate if you're using chlorinated city water). Warm water is easier on the plants.
    b. Water according to the age of your crop. The younger plants are, the more often they need water and the smaller the amount needed. Seedlings need a gentle misting once or twice a day. More mature plants have deeper roots and need deep watering, but not so frequently (once per week or so).
    c. Water according to your soil type. Sandy soil needs more frequent, small doses of water; heavy, clay soil needs less frequent watering in larger amounts. When in doubt, check the soil an inch or two below the surface. If it's damp, don't water it.
    d. Consult the seed catalog or a good gardening book for information on the watering needs of specific crops. Some need more water than others. Planting crops with similar needs in the same block will make watering easier.
    e. Make sure your soil has plenty of organic matter. This helps the soil hold water, and also helps water move freely into and through the soil.

f. Mulching will help conserve water and moderate soil temperature. It also helps control weeds, which compete with your crops for water. Experiment with what you have available: newspapers, pine straw, hay, grass clippings, ground bark, even old carpet can all make good mulch.

g. Try to put the water on the ground at the foot of each plant, not on the leaves. This saves water and helps prevent plant diseases. Shaping the soil into shallow wells or furrows helps direct the water where it is most needed.

h. Water in the morning if you can. Less water will be lost to evaporation, and the plants will be dry by night so they won't have fungus problems.

4. Weeds, pests and diseases. If your garden has good, rich soil, and if you follow the recommendations for spacing and watering, your plants will be healthy and resistant to pests. Inspect your garden daily to catch problems as early as possible.

. Remove weeds as soon as you see them. The regular spacing in a Square Foot Garden makes it easy to spot weeds; they look out of place.

b. Remove any plant that appears diseased. This can save the rest of your plants.

c. Many books and magazines have information on specific pests. In general, remember that prevention and hand-picking are the safest, cheapest and most effective pest controls.

PLANTS RECOMMENDED FOR BEGINNERS

The plants on this list are easy to grow in most places in the continental U.S. If your garden has special problems, see the next section. We have concentrated mainly on plants that don't need a great deal of space or special structures like trellises. If you have a trellis or a fence, you may want to try pole beans, cherry tomatoes (The Plant that Would Not Die!), squash, hyacinth bean (Dolichos lablab), morning glories, or balloon vine (Cardiospermum halicacabum, also called love-in-a-puff).

Vegetables and Herbs: Asparagus (perennial), basil, beans, beets, carrots, chives (perennial), corn, corn salad (also called mache or lamb's lettuce), dill, garden cress (also called peppergrass), horseradish (perennial), Jerusalem artichoke (perennial; also called sunchoke), leaf lettuce, peas, potatoes, radishes, rutabagas, salsify, snow peas, Swiss chard, turnips.

Flowers: Bachelor's buttons (Centaurea cyanus, also called ragged-robins), California poppies (Eschscholzia californica), calliopsis (Coreopsis tinctoria), cosmos, marigolds, nasturtiums, sunflowers.

WHAT TO GROW IF YOUR GARDEN IS TOO (SOMETHING)

Almost any garden problem can be improved over time, but if conditions in your garden are less than ideal and you want to grow something RIGHT NOW, here are some ideas.

TOO COLD: Snowpeas, kale, rhubarb and spinach are the ultimate cold-season crops. Other good contenders are the brassicas: broccoli, cauliflower, cabbage, turnips, brussels sprouts and radishes. Carrots and beets like cool weather. For flowers, try calendula, snapdragons, larkspur, pansies, violas, stock, Chinese forget-me-nots, sweet alyssum, baby blue eyes, sweet peas, and California poppies. Raised beds will help the soil warm up; so will dark-colored mulch applied after the

warming process has begun. You may also want to consider using cold frames, plastic tunnels, or other "season extenders".

TOO HOT: Hot peppers, okra, cowpeas, corn, peanuts, pumpkins, squash, sweet potatoes, watermelon and tomatoes are all heat-loving crops. Flowers that do well in heat are salvia (sage), yarrow, marigolds, petunias, zinnias, coreopsis, verbena, portulaca, cosmos, and sunflowers. Gourds also like heat and are easy to grow. A thick mulch is helpful; it cools the soil and the roots of the plants, and helps retain water. Using shade cloth, or planting tall crops to cast some shade on shorter ones during the afternoon, can also help.

TOO DRY: Many herbs are drought-resistant once they reach full size. Drought-tolerant flowers include lamb's ears, alyssum, violets, bachelor's buttons, and zinnias. For a drought-tolerant vegetable, try tepary beans; they are native to the Southwest and have deep root systems. Compost helps the soil hold more water; a thick layer of mulch slows down evaporation.

TOO WET: Lots of moisture is seldom a problem unless drainage is poor. Very few plants will tolerate "wet feet" and most of those that will are perennials. Try Siberian iris, cardinal flower, ox-eye daisies, elderberry (a small tree), mint (warning: it can take over the entire garden), garden cress, or watercress (for really wet areas, i.e. stream banks). Bad drainage is difficult to correct; raised beds are one possible answer to this problem. Adding sand and/or lots of compost may help, too.

TOO ACIDIC: Most plants do fine in slightly acidic soil. The champion acid-tolerant plants are fennel; blueberry and its annual relative, garden huckleberry (Solanum nigrum), and potatoes. Other plants that will tolerate moderately acid soil are sweet potatoes, shallots, watermelon, tomatoes, radishes and marjoram. Adding lots of compost may help tone down the acidity of your soil; lime and wood ashes are helpful for very acidic soil. Ask your county extension agent for help.

TOO ALKALINE: This is a bigger problem than acidity. Asparagus, beets, lentils, broccoli, lettuce, onions, cauliflower, celery and muskmelons will grow in slightly alkaline soil. Flowers and herbs that tolerate some alkalinity include alyssum, larkspur, candytuft, dianthus, thyme, savory, and nasturtiums. If your soil is very alkaline, you will need to correct the problem with sulfur or other soil amendments. Ask your extension agent for advice.

TOO SANDY: Many of the common herbs used in cooking originated in the Mediterranean area and do quite well in sandy soil. In addition strawberries, beets, Swiss chard, New Zealand spinach, potatoes, carrots, rutabagas and radishes do well in sandy soil if compost is added. Beans, peanuts, chives, nasturtiums and sweet potatoes will grow in sandy soil as well. Adding lots of compost will help sandy soils hold more water and nutrients. TOO HARD: If you have clay, adobe, or caliche soil you may need to add considerable organic matter to enable seeds to sprout and air and water to move through the soil. Until you get it into shape, try broccoli, cabbage, cauliflower or mustard greens grown from transplants. You might also plant some clover as a cover crop (till it under to add organic matter). A thick mulch will keep the surface of the soil from forming a hard crust.

TOO SHADY: Few plants will grow in deep shade, but many of the root and leaf crops will do fine in partial shade, especially in hot weather. Peas, beans, leeks, and summer squash will tolerate

some shade. For flowers, try foxglove, coleus, impatiens, and violets. Herbs that will grow in partial shade include lemon balm, lemon verbena, mints (warning! mints will take over your garden!), chives, sweet woodruff, thyme, sage, dill, parsley, and basil. Sometimes you can improve a shady problem area by trimming branches to admit more sun, or by using a light-colored wall or light-colored mulch to reflect more light onto the plants.

TOO SALTY: A vexing problem. If you live near the ocean, however, the availability of seaweed, an excellent mulch, almost makes up for the salt problem (rinse seaweed in fresh water before using it as mulch). Asparagus, potatoes and many herbs are salt-tolerant. Shallow rooted crops, such as lettuce and other greens, may do well since their roots stay above the salty groundwater. Raised beds are sometimes helpful.

TOO BIG: Yes, it is possible to have a garden that is too big for the available manpower. Divide the space in half: use one half for your garden plants and the other for a cover crop, such as clover, that can be tilled under to enrich the soil. Then reverse the two the following year. If this doesn't appeal to you, try growing pumpkins. A single plant of a large variety of pumpkin can cover 50 square feet or more, and its huge leaves will shade out the weeds. (It will also deplete your soil, so remember to add lots of compost before planting anything else in that space.)

TOO SMALL: A much more common problem. Grow small plants. Grow plants that mature quickly so you can harvest more than one crop per season. Grow vining plants such as pole beans, cucumbers and tomatoes and train them up a trellis. Plant in containers.

HOPELESS: Some plants will grow just about anywhere. Try cherry tomatoes, Jerusalem artichokes (not an artichoke but a perennial sunflower with edible tubers), peas, beans, radishes, thyme, yarrow, rosemary, daisies, coreopsis or cosmos. You might also try growing in containers.

ALL-PURPOSE ADVICE: Whatever your climate, you can do an end run around poor conditions by growing native plants. Your extension agent can recommend native wildflowers; so can many of the seed catalogs that specialize in wildflowers. The anthropology or horticulture department of the nearest university may be able to point you to plants grown by native peoples in your area. Heirloom varieties of garden plants adapted to your locale are also a good bet. Here are a few sources of seeds adapted to particular areas; check gardening magazines for more sources that fit your particular needs.

Pacific Northwest:

Abundant Life Seed Foundation

P.O. Box 772

Port Townsend, WA 98368

($5 for catalog and newsletters)

Desert Southwest:

Native Seeds/SEARCH

3950 W. New York Dr.

Tucson, AZ 85745

($1 for catalog; specializes in Native American and heirloom crops)

Mid-Atlantic:

Southern Exposure Seed Exchange

P.O. Box 158

North Garden, VA 22959

($2 for catalog; many heirloom varieties)

Southeast:

Southern Garden Co.

P.O. Box 200 D-6

10800 Alpharetta Hwy.

Roswell, GA 30076

(free catalog)

Hot Climates:

Southern Seeds

P.O. Box 2091

Melbourne, FL 32902

($2 for catalog)

Cold Climates:

Rawlinson Garden Seed

269 College Rd.

Truro, Nova Scotia

B2N 2P6 Canada

($1 for catalog; free to Atlantic Canada, Quebec, and Ontario)

Northplan/Mountain Seed

P.O. Box 9107

Moscow, ID 83483

($1 for catalog, refundable with order. Seeds for short seasons or higher elevations)

Johnny's Selected Seeds

305 Foss Hill Rd.

Albion, ME 04910

(free catalog)

CURRICULUM SUGGESTIONS

English or Language Arts

Keep a gardening journal. Exchange letters or e-mail with other schools involved in Square Foot projects (list available from the SFG Foundation). Study the many examples of writing about gardens and gardening: John Gerard, John Parkinson, Gertrude Jekyll, W. B. Yeats, E. B. White, et al. If a plant fails to thrive, use research and deductive reasoning to find out why.

Science

Many kinds of experiments are possible: comparing different varieties, different gardening methods, different fertilizers, etc. Botany, ecology, geology, and decomposition (composting) are all part of a working garden.

Math

Try charting the growth or yield of plants, calculating the number of plants that can be grown in a given area, calculating the area of a particular piece of land, measuring the angle of sunlight, tracking temperature and rainfall, etc.

Social Studies

Study the plants grown by various cultures and their uses. Prepare a meal using foods from the garden. Study the impact of the introduction of plants from one part of the world to another (sugar cane, tea and potatoes all had profound impacts on politics and history).

History

Study the agricultural history of your area and compare heirloom varieties to modern hybrids, while comparing the agricultural methods used in different eras.

Art

Make leaf rubbings, draw or paint the plants and animals in the garden, grow and use dye plants, press flowers. P.E. Gardening is good exercise! Hauling away rocks, cultivating a new garden spot, and carrying water are particularly recommended (just kidding).

AFTERWORD

This guide is still being revised. If you have suggestions for improving it, please contact us and we'll include them in the next version!

Lila F. Ralston

164 Merlin Drive

Athens, GA 30606

Return to the Square Foot Gardening Path

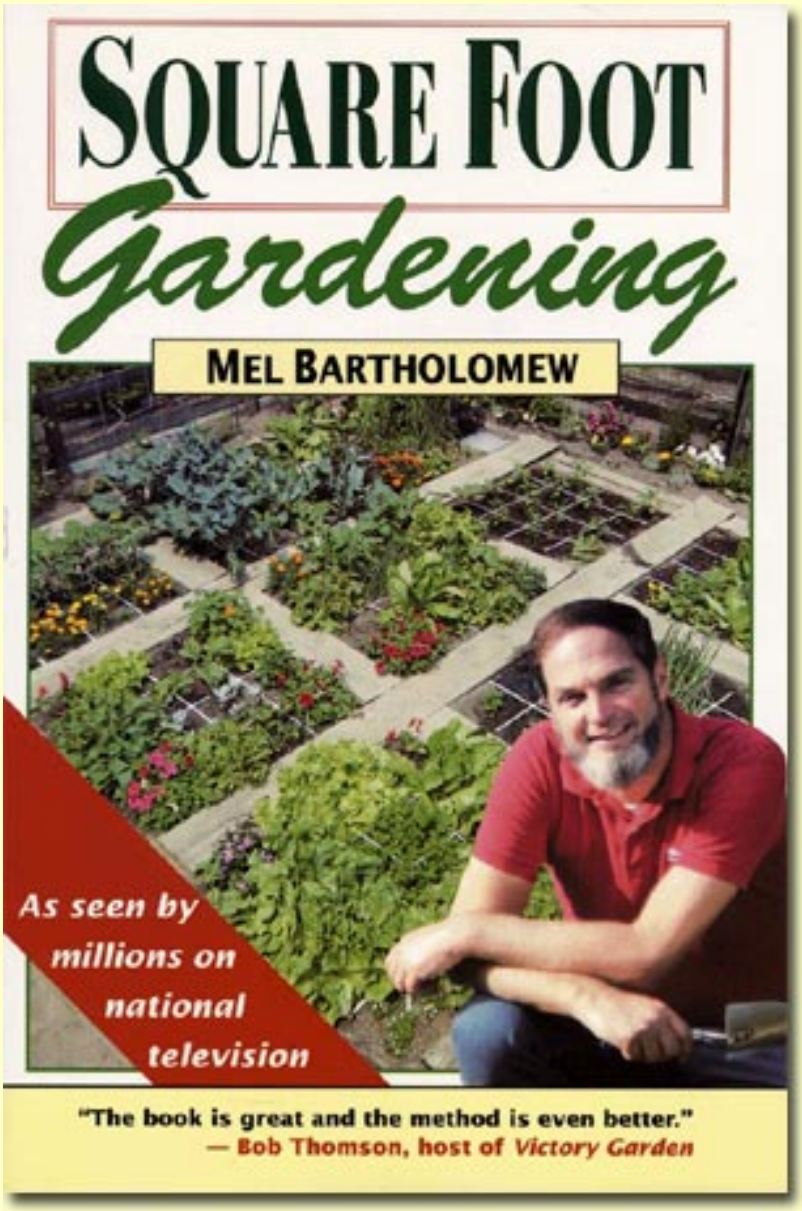
Return to Farmer Brown's Garden Path

Return to Farmer Browns Main Path

SQUARE FOOT Gardening™

The Official Site of Square Foot Gardening and Mel Bartholomew, Originator and Author

Product Catalog



1/5 the space
1/10 the water
1/20 the effort
THE SAME YIELD!

THE ORIGINAL BOOK

Book - Square Foot Gardening
Best selling gardening book in America. Over 1 million copies sold to date. 347 pgs. Illustrated. $16.95 + 3.95 S/H

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Read this buyers quote:

"**An eye-opening approach** to gardening--Mel Bartholemew starts by questioning why we plant gardens the same way huge businesses plant farms (long rows, overseeding, thinning, weeding) and concludes there's no good reason for it.

Then he turns the garden planning process **on its head**--rather than starting with what you want to grow, start with what you want to harvest and how often you want it. Does a 2-person house need a 100-foot row of carrots? Does ANYONE need 10 zucchini plants? His approach saves on weeding, watering and fertilizer and is far less wasteful of seeds."

SFG is not only an efficeint and new way to garden--It's actually a philosophy of Life

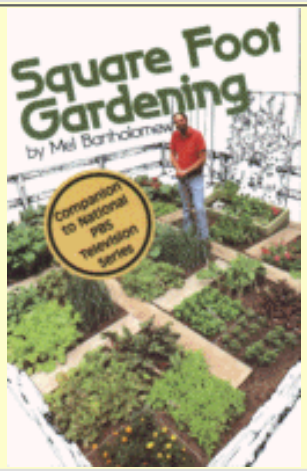
<<Prev Home Next>>

Square Foot Gardening

in the

Land of Goshen

Steven and Paula Hicks



We used the method described by Mel Bartholomew, in his famous book and the PBS Television Series.

We purchased 8 untreated* 2x12s, 8 feet long and cut each one in four foot pieces. We were fortunate to find a salvage yard selling #3 grade 2x12s for $7.95 each. Then we fastened them together with long "sheet rock screws". We pre-drilled pilot holes for the screws to make it easier to drive the screws with an electric drill. As you can see, we overlapped one end on each corner which made the inside dimensions 46½" square. We completed the four, 4x4 Square Foot Garden boxes in one evening. Next, using the imprint on the grass from the boxes, we removed the grass from each square with a flat blade shovel and leveled the boxes as best we could. At this point, Paula began to mix soil according to Mel's recipe from his book. She added some rich loamy soil from a nearby wooded area after sifting it through a 1/4" wire mesh. We chose not to "dig down" because we have very rocky soil and hard clay one-inch below the grass. Also, we found the raised beds to be easier to tend than those level with the ground.

NOTE: See this link Use of Treated Lumber for Square Foot Gardening before purchasing your lumber. Untreated lumber will rot quickly unless treated with an organic preservative such as linseed oil. You can also wrap the lumber in plastic.

"Goal-Post Trellises" Here are two photos taken on (a very cloudy) Memorial Day in 1998. They show our newly completed trellises for our beans, peas, cucumbers and cantaloupes. I call them "goal-post trellises" because they resemble the old style goal posts used on football fields years ago. I used treated 2x2 inch stock, obtained by ripping 2x4s and fastening them together with the extra long sheet rock screws. The trellises are also fastened to the 4x4 foot boxes with three screws on each side.

There is a row of screw hooks on the edge of the 2x12 at the bottom and a corresponding row of screw hooks on the underside of the cross-brace at the top. I also drilled holes in the (center) cross-brace for the strings to pass through. I used a knot called a "taught-line hitch" which is the common knot used on tent ropes. The taught-line hitch makes it easy to

re-tighten the strings from time to time.

The strings are made of large, cotton cord and can be easily composted in the Fall along with the dead vines. In the Winter, I remove the trellises with my electric drill and hang them on the side of the tool house until Spring.

The photos below are from our our 1998 season, which was dry and hot. We had lettuce, cucumbers, eggplant, okra, butter beans and green beans but the extreme heat caused us to have a very small crop. Our tomatoes were not planted in our Square Foot Gardens. Instead, they were planted in nearby hay bales, a technique which we have seen used with much success. They did well until the heat and the drought struck in late July. As of mid-October, we still harvested an occasional ripe tomato.

As you can see, our "goal-post trellises" worked out great! We can heartily recommend them. They were easy to build and the all-wood construction blended in well to make the SFGs even more attractive. Our bean, pea and cucumber vines began to rapidly climb the trellises as soon as we attached the strings. Soon, they were thoroughly covered. The pea vines climbed across, one to another, to form an "archway" between the two trellises.

If you have questions, comments or suggestions, we would like to hear from you! If you are a Square Foot Gardener, re-visit often for more photos. Also, we would like to see your SFG photos. Please e-mail us at:

shicks@aristotle.net

Steve and Paula Hicks

North Little Rock, Arkansas

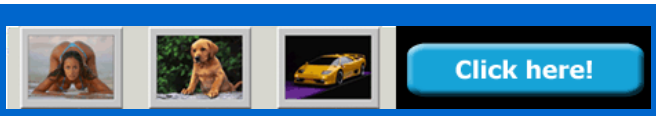
Zone 7

Square Foot Gardening Links:

- Judy's Square Foot Garden Page
- Use of Treated Lumber for Square Foot Gardening

Do you have a Square Foot Gardening site or a link that you would like to suggest? Please e-mail it to us. shicks@aristotle.net

back to the Land of Goshen



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Start
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Audio CD Maker	File Scavenger	Arcade Lines
The easiest way to create audio CD's	Recover deleted files, formatted partitions, virus-damaged disks, and more...	Highly addictive fun puzzle game for all ages
Advanced WMA Workshop	WinGuides Tweak Manager	2M Blocks Swapper
WMA 8 encoder/decoder with nice GUI interface	Control your Windows system with tweaks and hidden settings	Swap blocks to destroy them. Great fun !
MP3 HTML Generator	Registry Mechanic	PacBomber
Create MP3 HTML list for your Web pages	A clean registry speeds up your computer!	Fun and addictive Pacman remake.
Advanced MP3/WMA Recorder	SpamButcher	Chess Workbook
Driect realtime to MP3/WMA recorder software	Spam filter stops 98% of unwanted e-mail	a chess training software based on the technique of flashcards.
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xena.pkiclue.com Mailing Lists

No such list *sqft-l*

There currently are no publicly-advertised mailman mailing lists on xena.pkiclue.com. To visit the info page for an unadvertised list, open a URL similar to this one, but with a '/' and the right list name appended.

List administrators, you can visit the list admin overview page to find the management interface for your list.

(Send questions or comments to mailman-owner@pkiclue.com.)

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version 2.0.12

Python Powered

No such list *sqft-l*

Index of /lists//sqft

Name	Last modified	Size	Description
Parent Directory	06-May-2004 03:57	-	

Square_Foot_Garden · Are you an avid FT2 Gardener or just beginning??? Square Foot Gardening is growing "alot" in a small area. You don't have to

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Description

Category: Gardening

Are you an avid FT2 Gardener or just beginning??? Square Foot Gardening is growing "alot" in a small area. You don't have to have acres of land -- *just a small space 4'x4'*. You can grow the maximum amount of vegetables (and flowers) in a smaller space than a traditional "row" garden.

This list is for the purpose of discussing topics associated with Square Foot Gardening (please reference the book by the same name by author Mel Bartholomew).

** JUST UPDATED!! ** We now have a Seed Exchange for members of Square Foot Gardening! Members of Square Foot Garden may view the database by visiting http://groups.yahoo.com/group/Square_Foot_Garden/database and choosing "Seed Inventory" database. To participate in the Seed Exchange please go to http://groups.yahoo.com/group/Square_Foot_Garden/files/SeedExchange for more information.

This is a moderated list and flaming, vulgar language, and the like will not be tolerated or allowed.

What's New

New within the last seven days:

Messages: **2**

Message History

Search Archive

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004		12	45	79	134	193	64	22				
2003	114	27	36	38	55	51	11	11	4		3	4
2002	54	18	57	27	59	4	29	33	43	8	3	5
2001	69	110	137	58	58	16	15	22	3	6	31	7
2000	101	216	63	44	50	82	33	18	3	6		25
1999	87	157	166	86	64	86	68	5	3	1	22	35
1998											66	76

Group Email Addresses

For more information: http://members.aol.com/PuPuTeDu/index.html

Post message: Square_Foot_Garden@yahoogroups.com

Subscribe: Square_Foot_Garden-subscribe@yahoogroups.com

Unsubscribe: Square_Foot_Garden-unsubscribe@yahoogroups.com

List owner: Square_Foot_Garden-owner@yahoogroups.com

Group Info

Members: **452**

Founded: **Nov 24, 1998**

Language: **English**

Group Settings

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Companion Planting

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**Avoid suspicion: when you're walking through your neighbor's melon patch,
don't tie your shoe - Chinese Proverb**

COMPANION PLANTING

Many plants have natural substances in their roots, flowers, leaves etc. that can alternately repel (anti-feedents) and/or attract insects depending on your needs. In some situations they can also help enhance the growth rate and flavor of other varieties. Experience shows us that using companion planting through out the landscape is an important part of integrated pest management. In essence companion planting helps bring a balanced eco-system to your landscape, allowing nature to do its' job.

By using companion planting, many gardeners find that they can

discourage harmful pests without losing the beneficial allies. There are many varieties of herbs, flowers, etc. that can be used for companion plants. Be open to experimenting and find what works for you. Some possibilities would be using certain plants as a border, backdrop or interplanting in your flower or vegetable beds where you have specific needs. Use plants that are native to your area so the insects you want to attract already know what to look for! Plants with open cup shaped flowers are the most popular with beneficial insects.

Companion planting can combine beauty and purpose to give you an enjoyable, healthy environment. Have fun, let your imagination soar. There are many ways you can find to incorporate these useful plants in your garden, orchard, flower beds etc.

Following is a basic plant guide (with some tips) to help you "work in harmony with nature."

Note: this guide is not intended to solve garden problems as the suggestions may work differently in various situations or not at all. Don't let that discourage you from giving the ideas a try! What works for some may not work for others and vice versa. Experimenting is the only way we can gain new insight for our own individual gardens.

PLANT GUIDE

ALFALFA: Perennial that roots deeply. Fixes the soil with nitrogen, accumulates iron, magnesium, phosphorous and potassium. Withstands droughts with it's long taproot and can improve just about any soil! Alfalfa has the ability to break up hard clay soil and can even send its' roots through rocks! Now that is a tenacious plant! Alfalfa is practically pest and disease free. It needs only natural rainfall to survive.

AMARANTH: A tropical annual that needs hot conditions to flourish. Good with sweet corn, it's leaves provide shade giving the corm a rich, moist root run. Host to predatory ground beetles. Eat the young leaves in salads.

ANISE: Licorice flavored herb, good host for predatory wasps which prey on aphids and it is also said to repel aphids. Deters pests from brassicas by camouflaging their odor. Improves the vigor of any plants growing near it. Used in ointments to protect against bug stings and bites. Good to plant with coriander.

ARTEMISIAS: See Wormwood

BASIL: Plant with tomatoes to improve growth and flavor. Basil can be helpful in repelling thrips. It is said to repel flies and mosquitoes. Do not plant near rue.

BAY LEAF: A fresh leaf bay leaf in each storage container of beans or grains will deter weevils and moths. Sprinkle dried leaves with other

deterrent herbs in garden as natural insecticide dust. A good combo: Bay leaves, cayenne pepper, tansy and peppermint.

- **For ladybug invasions** try spreading bay leaves around in your house anywhere they are getting in and they should leave.

BEANS: All bean enrich the soil with nitrogen fixed form the air. In general they are good company for carrots, brassicas, beets, and cucumbers. Great for heavy nitrogen users like corn and grain plants. French Haricot beans, sweet corn and melons are a good combo. Keep beans away from the alliums.

BEE BALM (Oswego, Monarda): Plant with tomatoes to improve growth and flavor. Great for attracting beneficials and bees of course. Pretty perennial that tends to get powdery mildew.

BEET: Good for adding minerals to the soil. The leaves are composed of 25% magnesium. Companions are lettuce, onions and brassicas.

BORAGE: Companion plant for tomatoes, squash and strawberries. Deters tomato hornworms and cabbage worms. One of the best bee and wasp attracting plants. Adds trace minerals to the soil and a good addition the compost pile. Borage may benefit any plant it is growing next to via increasing resistance to pests and disease. After you have planned this annual once it will self seed.

BRASSICA: Benefit from chamomile, peppermint, dill, sage, and rosemary. They need rich soil with plenty of lime to flourish.

BUCKWHEAT: Accumulates calcium and can be grown as an excellent cover crop. Attracts hoverflies in droves. (Member of the brassica family.)

CARAWAY: Good for loosening compacted soil with it's deep roots. Tricky to establish. The flowers attract a number of beneficial insects.

CATNIP: Deters flea beetles, aphids, Japanese beetles, squash bugs, ants and weevils. We have found it repels mice quite well: mice were wreaking havoc in our outbuildings, we spread sprigs of mint throughout and the mice split! Use sprigs of mint anywhere in the house you want deter mice and ants. Smells good and very safe.

CHAMOMILE, GERMAN: Annual. Improves flavor of cabbages, cucumbers and onions. Host to hoverflies and wasps. Accumulates calcium, potassium and sulfur, later returning them to the soil. Increases oil production from herbs. Leave some flowers unpicked and German chamomile will reseed itself. Roman chamomile is a low growing perennial that will tolerate almost any soil conditions. Both like full sun. Growing chamomile of any type is considered a tonic for anything you grow in the garden.

CHERVIL: Companion to radishes for improved growth and flavor. Keeps aphids off lettuce. Likes shade.

CHIVES: Improves growth and flavor of carrots and tomatoes . Chives may drive away Japanese beetles and carrot rust fly. Planted among apple trees it may help prevent scab. A tea of chives may be used on cucumbers to prevent downy mildew. See chive tea on disease page.

CHRYSANTHEMUMS: C. coccineum kills root nematodes. (the bad ones) It's flowers along with those of C. cineraruaefolium have been used as botanical pesticides for centuries. (i.e. pyrethrum) White flowering chrysanthemums repel Japanese beetles. To the right is a picture of the painted daisy from which pyrethrum is extraxted.

CLOVER: Long used as a green manure and plant companion. Attracts many beneficials. Useful planted around apple trees to attract predators of the woolly aphid.

COMFREY: Accumulates calcium, phosphorous and potassium. Likes wet spots to grow in. Traditional medicinal plant. Good trap crop for slugs. More on comfrey.

CORIANDER: Repels aphids, spider mites and potato beetle. A tea from this can be used as a spray for spider mites. A partner for anise.

COSTMARY: This 2-3 foot tall perennial of the chrysanthemum family helps to repel moths.

DAHLIAS: These beautiful, tuberous annuals that can have up to dinner plate size flowers repels nematodes!

DILL: Improves growth and health of cabbage. Do not plant near carrots. Best friend for lettuce. Attracts hoverflies and predatory wasps. Repels aphids and spider mites to some degree. Also may repel the dreaded squash bug! (scatter some good size dill leaves on plants that are suspect to squash bugs, like squash plants, yeah that's the ticket.) Dill goes well with onions and cucumbers. Dill does attract the tomato horn worm so it would be useful to plant it somewhere away from your tomato plants to keep the destructive horn worm away from them. We like to plant it for the swallowtail butterfly caterpillars to feed on. Even their caterpillars are beautiful.

ELDERBERRY: A spray (see insect treatments) made from the leaves can be used against aphids, carrot root fly, cuke beetles and peach tree borers. Put branches and leaves in mole runs to banish them. Yes, it works!

FLAX: Plant with carrots, and potatoes. Flax contains tannin and linseed oils which may offend the Colorado potato bug. Flax is an annual from 1-4 feet tall with blue or white flowers that readily self sows. We have quite a few flax plants return year after year here in zone 5.

FOUR-O'CLOCKS: Draw Japanese beetles like a magnet which then dine on the foliage. The foliage is pure poison to them and they won't live to have dessert! It is important to mention that Four O"clocks are also poisonous to humans. Please be careful where you plant them if you have children. They are a beautiful annual plant growing from 2-3 feet high with a bushy growth form.

GARLIC: Plant near roses to repel aphids. Accumulates sulfur: a naturally occurring fungicide which will help in the garden with disease prevention. Garlic is systemic in action as it is taken up the plants through their pores and when used as a soil drench is also taken up by the roots. Has value in offending codling moths, Japanese beetles, root maggots, snails, and carrot root fly. Researchers have observed that time-released garlic capsules planted at the bases of fruit trees actually kept deer away! Hey, worth a try! Concentrated garlic sprays have been observed to repel and kill whiteflies, aphids and fungus gnats among others with as little as a 6-8% concentration! It is safe for use on orchids too.

- **Try our concentrated Garlic Barrier Insect Repellent!**

Geranium: -Repels cabbage worms and Japanese beetles, plant around grapes, roses, corn, and cabbage.

GOPHER PURGE: Deters gophers, and moles.

HORSERADISH: Plant in containers in the potato patch to keep away Colorado potato bugs. There are some very effective insect sprays that can be made with the root. Use the bottomless pot method to keep horseradish contained. Also repels Blister beetles. We have observed that the root can yield anti-fungal properties when a tea is made from it. (See: Horseradish: Disease)

HOREHOUND: Stimulates and aids fruiting in tomatoes.

HYSSOP: Companion plant to cabbage and grapes, deters cabbage moths and flea beetles. Do not plant near radishes. Hyssop may be the number one preference among bees and some beekeepers rub the hive with it to encourage the bees to keep to their home. It is not as invasive as other members of the mint family making it safer for interplanting.

KELP: When used in a powder mixture or tea as a spray, this versatile sea herb will not only repel insects but feed the vegetables. In particular we have observed that kelp foliar sprays keep aphids and Japanese beetles away when used as a spray every 8 days before and during infestation times. If you have access to seaweed, use it as a mulch to keep slugs away.

LAMIUM: This will repel potato bugs- a big problem for many gardeners!

LARKSPUR: An annual member of the Delphinium family, larkspur

will attract Japanese beetles. They dine and die! Larkspur is poisonous to humans too!

LAVENDER: Repels fleas and moths. Prolific flowering lavender nourishes many nectar feeding and beneficial insects. Use dried sprigs of lavender to repel moths. Start plants in winter from cuttings, setting out in spring.

LEEKS: Use leeks near carrots, celery and onions which will impove their growth. Leeks also repel carrot flies.

LEMON BALM: Sprinkle throughout the garden in an herbal powder mixture to deter many bugs. Lemon balm has citronella compounds that make this work: crush and rub the leaves on your skin to keep mosquitoes away! Use to ward off squash bugs!

LOVAGE: Improves flavor and health of most plants. Good habitat for ground beetles. A large plant, use one planted as a backdrop. Similar to celery in flavor.

MARIGOLDS: (Calendula): Given a lot of credit as a pest deterrent. Keeps soil free of bad nematodes; supposed to discourage many insects. Plant freely throughout the garden. The marigolds you choose must be a scented variety for them to work. One down side is that marigolds do attract spider mites and slugs.

- French Marigold (T. Patula) has roots that exude a substance which spreads in their immediate vicinity killing nematodes. For nematode control you want to plant dense areas of them. There have been some studies done that proved this nematode killing effect lasted for several years after the plants were These marigolds also help to deter whiteflies when planted around tomatoes and can be used in greenhouses for the same purpose. Whiteflies hate the smell of marigolds.
- Mexican marigold (T. minuta) is the most powerful of the insect repelling marigolds and may also overwhelm weed roots such as bind weed! It is said to repel the Mexican bean beetle and wild bunnies! Be careful it can have an herbicidal effect on some plants like beans and cabbage.

MARJORAM: As a companion plant it improves the flavor of vegetables and herbs. Sweet marjoram is the most commonly grown type.

MINT: Deters white cabbage moths, ants, rodents, flea beetles, fleas, aphids and improves the health of cabbage and tomatoes. Use cuttings as a mulch around members of the brassica family. It attracts hoverflies and predatory wasps. Earthworms are quite attracted to mint plantings. Be careful where you plant it as mint is an incredibly invasive perennial. We have found that placing mint (fresh or dried) where mice are a problem is very effective in driving them off!

MOLE PLANTS: (castor bean plant) Deter moles and mice if planted here and there throughout the garden. Drop a seed of this in mole runs to drive them away. This is a poisonous plant. See Moles: Critter Trouble

MORNING GLORIES: They attract hoverflies. Plus if you want a fast growing annual vine to cover something up morning glory is an excellent choice.

OPAL BASIL: An annual herb that is pretty, tasty and said to repel hornworms!

PEAS: Peas fix nitrogen in the soil. Plant next to corn and they will provide extra nitrogen. Corn is a heavy feeder so this is a great combination!

NASTURTIUMS: Plant as a barrier around tomatoes, radishes, cabbage, cucumbers, and under fruit trees. Deters wooly aphids, whiteflies, squash bug, cucumber beetles and other pests of the curcurbit family. Great trap crop for aphids (in particular the black aphids) which it does attract, especially the yellow flowering varieties. Likes poor soil with low moisture and no fertilizer. It has been the practice of some fruit growers that planting nasturtiums every year in the root zone of fruit trees allow the trees to take up the pungent odor of the plants and repel bugs. It has no taste effect on the fruit. A nice variety to grow is Alaska which has attractive green and white variegated leaves. The leaves, flowers and seeds are all edible and wonderful in salads!
Try our recipe for: Nasturtium Salad

NETTLES, STINGING: The flowers attract bees. Sprays made from these are rich in silica and calcium. Invigorating for plants and improves their disease resistance. Leaving the mixture to rot, it then makes an excellent liquid feed. Comfrey improves the liquid feed even more. Hairs on the nettles' leaves contain formic acid which "stings" you.

PARSLEY: Plant among and sprinkle on tomatoes, and asparagus. Use as a tea to ward off asparagus beetles. Attracts hoverflies. Let some go to seed to attract the tiny parasitic wasps. Parsley increases the fragrance of roses when planted around their base. Rose problems? See: Rose Rx for answers.

PEPPERMINT: Repels white cabbage moths, aphids and flea beetles. It is the menthol content in mints that acts as an insect repellant. Bees and other good guys love it.

PEPPERS, HOT: Chili peppers have root exudates that prevent root rot and other Fusarium diseases. Plant anywhere you have these problems. Teas made from hot peppers can be useful as insect sprays.

PENNYROYAL: Repels fleas. Many people are now using pennyroyal as an alternative lawn. The leaves when crushed and rubbed onto your skin will repel chiggers, flies, gnats, mosquitoes and ticks. Smells nice

too!

PETUNIAS: They repel the asparagus beetle, leafhoppers, certain aphids, tomato worms, Mexican bean beetles and general garden pests. A good companion to tomatoes, but plant everywhere. The leaves can be used in a tea to make a potent bug spray.

POACHED EGG PLANT: Grow poached egg plant with tomatoes, they will attract hover flies and hover flies eat aphids.

PURSLANE: This edible weed makes good ground cover in the corn patch. Use the stems, leaves and seeds in stir-frys. Pickle the green seed pod for caper substitutes.

RADISH: Plant radishes with your squash plants. Radishes may protect them from squash borers! Anything that will help prevent this is worth a try. Planting them around corn and letting them go to seed will help fight corn borers.

ROSEMARY: Companion plant to cabbage, beans, carrots and sage. Deters cabbage moths, bean beetles, and carrot flies. Use cuttings to place by the crowns of carrots for carrot flies. Zones 6 and colder can overwinter rosemary as houseplants or take cuttings.

RUE: Deters Japanese beetles in roses and raspberries. To make it even more effective with Japanese beetles: crush a few leaves to release the smell. Repels flies and has helped repel cats for us. Some say you should not plant it near cabbage, basil or sage. A pretty perennial with bluish-gray leaves. May be grown indoors in a sunny window. Rue can cause skin irritation! Remedy: See cats and dogs: Rue spray.

SAGE: Use as a companion plant with broccoli, cauliflower, rosemary, cabbage, and carrots to deter cabbage moths, beetles, black flea beetles and carrot flies. Do not plant near cucumbers or rue. Sage repels cabbage moths and black flea beetles. Allowing sage to flower will also attract many beneficial insects and the flowers are pretty. There are some very striking varieties of sage with variegated foliage that can be used for their ornamental as well as practical qualities. More on sage.

SOUTHERNWOOD: Plant with cabbage, and here and there in the garden. Wonderful lemony scent when crushed or brushed in passing. Roots easily from cuttings. Does not like fertilizer! It is a perennial that can get quite bushy. We have started to cut it back every spring and it comes back in not time. A delightful plant that is virtually pest free.

SOYBEANS: They add nitrogen to the soil making them a good companion to corn. They repel chinch bugs and Japanese beetles. Soybeans are so good for you! They are many ways to prepare them.

SUMMER SAVORY: Plant with beans and onions to improve growth and flavor. Discourages cabbage moths. Honey bees love it.

SUNFLOWERS: Planting sunflowers with corn is said by some to increase the yield. Aphids a problem? Definitely plant a few sunflowers here and there in the garden. Step back and watch the ants herd the aphids onto them! We have been doing this for years and it is remarkable. The sunflowers are so tough that the aphids cause very little damage and we have nice seed heads for our birds to enjoy! Talk about a symbiotic relationship!

TANSY: Plant with fruit trees, roses and raspberries keeping in mind that it can be invasive and is not the most attractive of plants. Tansy which is often recommended as an ant repellant may only work on sugar type ants. These are the ones that you see on peonies and marching into the kitchen. At least for us placing tansy clippings by the greenhouse door has kept them out. Deters flying insects, Japanese beetles, striped cucumber beetles, squash bugs, ants and mice! Tie up and hang a bunch of tansy leaves indoors as a fly repellent. Use clippings as a mulch as needed. Don't be afraid to cut the plant up as tansy will bounce back from any abuse heaped on it! It is also a helpful addition to the compost pile with its' high potassium content.

- **Tansy Warning: You do not want to plant Tansy anywhere that livestock can feed on it as it is toxic to many animals. Do not let it go to seed either as it may germinate in livestock fields.**

TARRAGON: Plant throughout the garden, not many pests like this one. Recommended to enhance growth and flavor of vegetables.

THYME: Deters cabbage worms. Wooly thyme makes a wonderful groundcover. You may want to use the upright form of thyme in the garden rather than the groundcover types. Thyme is easy to grow from seeds or cuttings. Older woody plants should be divided in spring.

WHITE GERANIUMS: These members of the pelargonum family draw Japanese beetles to feast on the foliage which in turn kills them.

WORMWOOD: Keeps animals out of the garden when planted as a border. An excellent deterrent to most insects. A tea made from wormwood will repel cabbage moths, slugs, snails, black flea beetles and fleas effectively. The two best varieties for making insect spray are Silver King and Powis Castle. Adversely Powis castle attracts ladybugs which in turn breed directly on the plant. Silver Mound is great as a border plant and the most toxic wormwood. Note: As wormwood actually produces a botanical poison do not use it directly on food crops.

See More on wormwood. for more details.
For insect spray: See wormwood spray

YARROW: Yarrow has insect repelling qualities and is an excellent natural fertilizer. A handful of yarrow leaves added to the compost pile really speeds things up. Try it! It also attracts predatory wasps and ladybugs to name just two. It may increase the essential oil content of herbs when planted among them. Yarrow has so many wonderful properties to it and is an ingredient in our own Golden Harvest Fertilizer.

Update: 08/10/04

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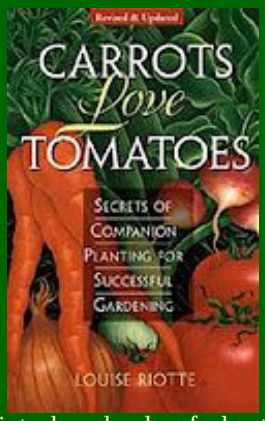

Lists hundreds of plants and their ideal (and not so ideal) companions. The new edition features a dozen illustrated garden plans.

TIPS AND TECHNIQUES: Tips and Techniques

Herb Companion Chart | Raised Beds

Vegetable Companion Chart

Plant	Good Companions	Bad Companions
Basil	Pepper, Tomato, Marigold	
Bush Beans	Beets, Cabbage, Carrots, Celery, Corn, Cucumbers, Eggplant, Lettuce, Pea, Radish, Strawberry, Savory, Tansy, Marigold	Onion
Pole Beans	Carrots, Corn Cucumber, Eggplant, Lettuce, Pea, Radish, Savory, Tansy	Beets, Onion
Beets	Bush Beans, Cabbage, Onion, Sage	
Cabbage Family	Bush Beans, Beets, Celery, Onions, Tomato, All Strong Herbs, Marigold, Nasturtium	Strawberry
Carrots	Bush Beans, Pole Beans, Lettuce, Onion, Peas, Radish, Tomato, Sage	Dill
Celery	Bush Beans, Cabbage, Onion, Spinach, Tomato	
Corn	Bush Beans, Pole Beans, Cucumber, Melons, Peas, Squash	Tomato
Cucumbers	Bush Beans, Pole Beans, Corn, Lettuce, Onions, Peas, Radish, Marigold, Nasturtium, Savory	No Strong Herbs
Eggplant	Bush Beans, Pole Beans, Spinach	
Lettuce	Bush Beans, Pole Beans, Carrots, Cucumbers, Onion, Radish, Strawberries	
Melons	Corn, Nasturtium, Radish	
Onion	Beets, Cabbage, Carrots, Celery, Cucumber, Lettuce, Pepper, Squash, Strawberries, Tomato, Savory	Bush Beans, Pole Beans, Peas
Parsley	Tomato	
Peas	Bush Beans, Pole Beans, Carrots, Corn Cucumber, Radish, Turnips	Onion
Pepper	Onion	
Radish	Bush Beans, Pole Beans, Carrots, Cucumber, Lettuce, Melons, Peas, Squash	Hyssop
Spinach	Celery, Eggplant, Cauliflower	
Squash	Corn, Onion, Radish	
Strawberry	Bush Beans, Lettuce, Onion, Spinach	Cabbage
Tomato	Cabbage, Carrots, Celery, Onion, Mint	Corn, Fennel

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White Yarrow

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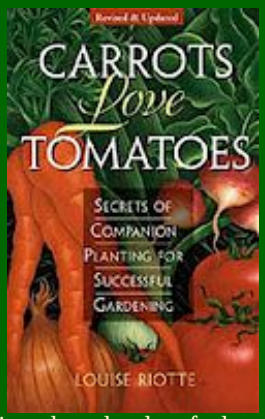

Lists hundreds of plants and their ideal (and not so ideal) companions. The new edition features a dozen illustrated garden plans.

The Secrets of

TIPS AND TECHNIQUES: Tips and Techniques

Beneficial Insects | Vegetable Companion Chart

Herb Companion Chart

The idea that herbs make good companion plants is not new. Some of the earliest written documents on gardening discuss these relationships. When selecting your companion plants you will need to consider more than which pests are deterred. Think about what each plant adds or takes away from the soil and what effect the proximity of strong herbs may have on the flavor of your vegetables. Try to avoid placing two heavy feeders or two shallow rooted plant types near each other.

Herb	Companions	Pests Repelled
Angelica	Avoid Dill	
Basil	Tomatoes Dislikes Rue	Flies, Mosquitoes
Borage	Tomatoes, Squash, Strawberries	Tomato Worm
Caraway	Plant throughout the garden to loosen the soil. Avoid Dill	
Catnip	Eggplant	Flea Beetle, Ants
Chamomile	Cabbage, Onion	
Coriander		Aphids
Chervil	Radish	
Chives	Carrots	
Dead Nettle	Potatoes	Potato Bug
Dill	Cabbage Dislikes Carrots and Caraway	
Fennel	Most plants dislike this herb	
Feverfew	roses	attracts aphids away from roses
Flax	Carrots, Potatoes	Potato Bug
Garlic	Roses, Raspberries	Japanese Beetle, Aphids
Horseradish	Potatoes	Potato Bug
Henbit		General Insect Repellent
Hyssop	Cabbage, Grapes Dislikes Radishes	Cabbage Moth

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Companion Planting with Flowers

Lavender		Moths -- combine with southernwood, wormwood and rosemary in an anti-moth sachet
Marigolds	Plant throughout the garden	Mexican Bean Beetles, Nematodes, others
Mint	Cabbage, Tomatoes	White Cabbage Moth, aphids, flea beetles
Mole Plant		Moles and Mice
Nasturtium	Radishes, Cabbage, Cucurbits, fruit trees	Aphids, Squash Bugs, Striped Pumpkin Beetle
Pennyroyal	Roses	Flies, Mosquitoes, Fleas, others
Petunia	Beans	
Pot Marigold	Tomatoes	Tomato Worm, Asparagus Beetles, others
Pyrethrums		Use dried flower heads as a general insect repellent.
Rosemary	Cabbage, Beans Carrots, Sage	Cabbage Moth, Bean Beetle, Carrot Fly
Rue	Roses and Raspberries Dislikes Sweet Basil	Japanese Beetles
Sage	Rosemary, Cabbage, Carrots Dislikes Cucumbers	Cabbage Moth, Carrot Fly, Flea Beetle, Slugs
Southernwood	Cabbages	Cabbage Moth
Sowthistle	Tomatoes, Onion, Corn Plant in moderation	
Summer Savory	Beans	Bean Beetles
Tansy	Fruit Trees, Roses, Raspberries	Flying Insects, Japanese Beetles, Striped Cucumber Beetles, Squash Bugs, Ants, Flies
Thyme	Cabbage	Cabbage Worm
Wormwood		Plant as a border to keep animals out of the garden.
Yarrow	Plant near aromatic herbs to enhance production of essential oils.	

White Yarrow

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Appropriate Technology Transfer for Rural Areas

Companion Planting: *Basic Concept and Resources*

Horticulture Technical Note

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By George Kuepper & Mardi Dodson
NCAT Agriculture Specialist and Project Intern
July 2001

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10 pages — 669 kb

Abstract:
Companion planting is based on the idea that certain plants can benefit others when planted in near proximity. The scientific and traditional bases for these plant associations are discussed. A companion planting chart for common herbs, vegetables, and flowers is provided, as is a listing of literature resources for traditional companion planting. An appendix provides history, plant varieties, and planting designs for the Three Sisters, a traditional Native American companion planting practice.

Traditional Companion Planting

Companion planting can be described as the establishment of two or more plant species in close proximity so that some cultural benefit (pest control, higher yield, etc.) is derived. The concept embraces a number of strategies that increase the biodiversity of agroecosystems.

Generally, companion planting is thought of as a small-scale gardening practice. However, in this discussion the term is applied in its broadest sense to include applications to commercial horticultural and agronomic crops. ATTRA has another publication, ***Intercropping Principles and Production Practices***, that provides additional information on larger-scale applications.

While companion planting has a long history, the mechanisms of beneficial plant interaction have not always been well understood. Traditional recommendations (see

summary chart provided as Table 1) used by gardeners have evolved from an interesting combination of historical observation, horticultural science, and a few unconventional sources. For example, some of the recommendations for companion planting, made around the middle of this century, were based on the results of sensitive crystallization tests (1).

Originally developed by Dr. Ehrenfried Pfeiffer, sensitive crystallization testing entails the mixing of plant extracts with select salt reagents like sodium sulfate or copper chloride. The resulting solution is placed in a controlled environment chamber and allowed to evaporate slowly. The process results in a precipitate that often takes on beautiful geometric forms and patterns. The characteristics of the pattern are studied and interpreted to establish whether the plants are likely to interact well with each other (1). Sensitive crystallization appeals to practitioners of Biodynamics™ (BD) and others who take a more metaphysical approach to nature. Conventional science is much more skeptical of this process as a means to evaluate plant associations.

Table 1. COMPANION PLANTING CHART FOR HOME & MARKET GARDENING
(compiled from traditional literature on companion planting)

CROP	COMPANIONS	INCOMPATIBLE
Asparagus	Tomato, Parsley, Basil	
Beans	Most Vegetables & Herbs	
Beans, Bush	Irish Potato, Cucumber, Corn, Strawberry, Celery, Summer Savory	Onion
Beans, Pole	Corn, Summer Savory, Radish	Onion, Beets, Kohlrabi, Sunflower
Cabbage Family	Aromatic Herbs, Celery, Beets, Onion Family, Chamomile, Spinach, Chard	Dill, Strawberries, Pole Beans, Tomato
Carrots	English Pea, Lettuce, Rosemary, Onion Family, Sage, Tomato	Dill
Celery	Onion & Cabbage Families, Tomato, Bush Beans, Nasturtium	
Corn	Irish Potato, Beans, English Pea, Pumpkin, Cucumber, Squash	Tomato

Cucumber	Beans, Corn, English Pea, Sunflowers, Radish	Irish Potato, Aromatic Herbs
Eggplant	Beans, Marigold	
Lettuce	Carrot, Radish, Strawberry, Cucumber	
Onion Family	Beets, Carrot, Lettuce, Cabbage Family, Summer Savory	Beans, English Peas
Parsley	Tomato, Asparagus	
Pea, English	Carrots, Radish, Turnip, Cucumber, Corn, Beans	Onion Family, Gladiolus, Irish Potato
Potato, Irish	Beans, Corn, Cabbage Family, Marigolds, Horseradish	Pumpkin, Squash, Tomato, Cucumber, Sunflower
Pumpkins	Corn, Marigold	Irish Potato
Radish	English Pea, Nasturtium, Lettuce, Cucumber	Hyssop
Spinach	Strawberry, Faba Bean	
Squash	Nasturtium, Corn, Marigold	Irish Potato
Tomato	Onion Family, Nasturtium, Marigold, Asparagus, Carrot, Parsley, Cucumber	Irish Potato, Fennel, Cabbage Family
Turnip	English Pea	Irish Potato

The Scientific Foundations for Companion Planting

While conventional agriculturalists and BD practitioners may disagree over the validity of sensitive crystallization research, there is general agreement today on the validity of several mechanisms that create beneficial plant associations:

» ***Trap cropping***. Sometimes, a neighboring crop may be selected because it is more attractive to pests and serves to distract them from the main crop. An excellent example of this is the use of collards to draw the diamond back moth away from cabbage (2).

» ***Symbiotic nitrogen fixation***. Legumes—such as peas, beans, and clover—have the ability to fix atmospheric nitrogen for their own use and for the benefit of neighboring plants via symbiotic relationship with Rhizobium bacteria. Forage legumes, for example, are commonly seeded with grasses to reduce the need for nitrogen fertilizer. Likewise, beans are sometimes interplanted with corn. On request ATTRA can provide additional information on Rhizobium inoculation.

» ***Biochemical pest suppression***. Some plants exude chemicals from roots or aerial parts that suppress or repel pests and protect neighboring plants. The African marigold, for example, releases thiopene—a nematode repellent—making it a good companion for a number of garden crops. The manufacture and release of certain biochemicals is also a factor in plant antagonism. Allelochemicals such as juglone—found in black walnut—suppress the growth of a wide range of other plants, which often creates a problem in home horticulture. A positive use of plant allelopathy is the use of mow-killed grain rye as a mulch. The allelochemicals that leach from rye residue prevent weed germination but do not harm transplanted tomatoes, broccoli, or many other vegetables.

» ***Physical spatial interactions***. For example, tall-growing, sun-loving plants may share space with lower-growing, shade-tolerant species, resulting in higher total yields from the land. Spatial interaction can also yield pest control benefits. The diverse canopy resulting when corn is companion-planted with squash or pumpkins is believed to disorient the adult squash vine borer and protect the vining crop from this damaging pest. In turn, the presence of the prickly vines is said to discourage raccoons from ravaging the sweet corn.

» ***Nurse cropping***. Tall or dense-canopied plants may protect more vulnerable species through shading or by providing a windbreak. Nurse crops such as oats have long been used to help establish alfalfa and other forages by supplanting the more competitive weeds that would otherwise grow in their place. In many instances, nurse cropping is simply another form of physical-spatial interaction.

» ***Beneficial habitats***. Beneficial habitats—sometimes called refugia—are another type of companion plant interaction that has drawn considerable attention in recent years. The benefit is derived when companion plants provide a desirable environment for beneficial insects and other arthropods—especially those predatory and parasitic species which help to keep pest populations in check. Predators include ladybird beetles, lacewings, hover flies, mantids, robber flies, and non-insects such as spiders and predatory mites. Parasites include a wide range of fly and wasp species including tachinid flies, and Trichogramma and ichneumonid wasps. Agroecologists believe that by developing systems to include habitats that draw and sustain beneficial insects, the twin objectives of reducing both pest damage and pesticide use can be attained. For detailed information on establishing beneficial habitats, request the ATTRA publication ***Farmscaping to Enhance Biological Control***.

» ***Security through diversity***. A more general mixing of various crops and varieties provides a degree of security to the grower. If pests or adverse conditions reduce or destroy a single crop or cultivar, others remain to produce some level of yield. Furthermore, the simple mixing of cultivars, as

demonstrated with broccoli in University of California research, can reduce aphid infestation in a crop (3).

Options For System Design

Agronomists use the term "intercropping" to describe the spatial arrangements of companion planting systems. Intercropping systems range from mixed intercropping to large-scale strip intercropping. Mixed intercropping is commonly seen in traditional gardens where two or more crops are grown together without a distinct row formation. Strip intercropping is designed with two or more crops grown together in distinct rows to allow for mechanical crop production. No-till planting or transplanting into standing cover crops can be considered another form of intercropping. For more information on no-till planting, request the ATTRA publication ***Conservation Tillage***.

Related ATTRA publications
• *Intercropping Principles and Production Practices*
• *Farmscaping to Enhance Biological Control*
• *Introduction to Permaculture*
• *Biodynamic Farming & Compost Preparation*
• *Conservation Tillage*

References:

1) Philbrick, Helen and Richard Gregg. 1966. Companion Plants & How To Use Them. The Devin-Adair Co., Old Greenwich, CT. 113 p.

2) Boucher, Jude. 2000. Setting a Trap. American Vegetable Grower. January. p. 20, 22.

3) Daar, S. 1988. Mixing Broccoli Cultivars Reduces Cabbage Aphids. IPM Practitioner. May. p. 12.

Resources:

Traditional Companion Planting

Bob Flowerdew's Complete Book of Companion Gardening. 1995. By Bob Flowerdew. Kyle Cathie, London, GB. 176 p.

Available online from:
Trafalgar Square Books for $24.95 plus $5 shipping and handling
http://www.trafalgarsquarebooks.com

Carrots Love Tomatoes: Secrets of Companion Planting for Successful Gardening, 2nd edition. 1998. By Louise Riotte. Storey Communications, Pownal, VT. 226 p.

Available for $15 plus $3 p&h from:
Acres USA
P.O. Box 91299 Austin, TX 78709
800-355-5313 • 512-892-4448 Fax

Email: info@acresusa.com

Companion Plants and How To Use Them. 1966. By H. Philbrick and R. Gregg.

Devin-Adair Publishers, Old Greenwich, CT. 113 p.

Available for $9.95 plus $4.50 p&h from:
Bio-Dynamic Farming and Gardening Association, Inc.
Building 1002B, Thoreau Center
The Presidio
P.O. Box 29135 San Francisco, CA 94129-0135
888-516-7797 • 415-561-7796 Fax
Email: biodynamic@aol.com website: http://www.biodynamics.com

Great Garden Companions: A Companion-Planting System for a Beautiful, Chemical-Free Vegetable Garden. 1998. By Sally Jean Cunningham. Rodale Press, Emmaus, PA. 278 pages.

Available for $13.56 plus $4.48 shipping and handling from:
Amazon Books http://www.amazon.com

How To Grow More Vegetables Than You Ever Thought Possible On Less Land Than You Can Imagine, 5th edition. 1995. By John Jeavons. Ten Speed Press, Berkeley, CA. 228 p.

Contains an extensive companion planting chart.
Available for $16.95 plus $4.50 p&h from:
Bountiful Gardens 18001 Shafer Ranch Rd. Willits, CA 95490-9626
707-459-6410

J. Howard Garret's Organic Manual. 1993. By J. Howard Garret. Lantana Publishing Co., Dallas, TX. 203 p.

A fine general guide on organic growing that features a brief table of companion herbs and the pests they repel on page 48. Available for $18 plus $3 p&h from:
Acres USA
P.O. Box 91299
Austin, TX 78709
800-355-5313 • 512-892-4448 Fax
Email: info@acresusa.com

Raising With The Moon: The Complete Guide to Gardening and Living by the Signs of the Moon. 1993. By Pyle & Reese. Down Home Press, Asheboro, NC. 147 p.

Contains both companion planting charts and a listing of insect repellent plants. Available for $14 plus $3 p&h from:
Acres USA
P.O. Box 91299
Austin, TX 78709
800-355-5313 • 512-892-4448 Fax
Email: info@acresusa.com

Rodale's Successful Organic Gardening: Companion Planting. 1994. By McClure and Roth. Rodale Press, Emmaus, PA. 160 p.

Available for $14.95 plus $4.50 p&h from:
Bountiful Gardens
18001 Shafer Ranch Rd.
Willits, CA 95490-9626
707-459-6410

Roses Love Garlic: Companion Planting and Other Secrets of Flowers. 1998. By Louise Riotte. Storey Communications, Pownal, VT. 240 p.

Available for $ 11.96 plus $4.48 shipping and handling from:
Amazon Books http://www.amazon.com

Beneficial Habitats

To avoid redundancy in our publications, anyone seeking further information on beneficial habitats is encouraged to request ATTRA's publication titled Farmscaping to Enhance Biological Control. This publication also provides additional references for further research. Other ATTRA publications that might be helpful for designing and managing beneficial habitats include ***Biointensive Integrated Pest Management*** and ***Overview of Cover Crops and Green Manures***.

Intercropping Research

ATTRA's ***Intercropping Principles and Production Practices and Farmscaping to Enhance Biological Control*** publications are good sources for basic information on intercropping. The following publications should prove useful.

"Border effects on yields in a strip-intercropped soybean, corn, and wheat production system." 1996. By T.K. Iragavarapu and G.W. Randall. Journal of Production Agriculture. Vol. 9, No. 1. p. 101-107.

Provides a nice literature review of research to that time on intercropping, highlighting the multitude of factors causing variability in results.

Multiple Cropping. 1976. ASA Special Publication No. 27. American Society of Agronomy, 677 So. Segoe Rd., Madison, WI. 378 p.

"Strip intercropping for biological control." 1993. By Joel Grossman and William Quarles. The IPM Practitioner. April. p. 1-11.

An excellent synopsis of intercropping. The IPM Practitioner, published 10 times per year, is a benefit of membership in the Bio-Integral Resource Center (BIRC). Annual membership for individuals costs $35. Contact:
BIRC
P.O. Box 7414
Berkeley, CA 94707
510-524-2567

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July 2001

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Ancient Companions

An Appendix to Companion Planting: Basic Concepts & Resouces

By Mardi Dodson

Introduction

For centuries, many Native American tribes throughout North America have cultivated corn, beans, and squash. The term "Three Sisters" was primarily used by the Iroquois who live in the Northeastern United States and Canada. These crops were considered to be special gifts from Great Spirit and were believed to be protected by the Three Sisters-spirits collectively called the De-o-ha-ko, meaning "our sustainers" or "those who support us" (1).

This ancient style of companion planting has played a key role in the survival of all people in North America. Grown together these crops are able to thrive and provide high-yield, high-quality crops with a minimal environmental impact. Corn, beans, and squash have a unique symbiotic relationship in a Native American garden. Corn offers a structure for the beans to climb. The beans, in turn, help to replenish the soil with nutrients. And the large leaves of squash and pumpkin vines provide living mulch that conserves water and provides weed control.

The Legend of the Three Sisters

The term "Three Sisters" emerged from the Iroquois creation myth. It was said that the earth began when "Sky Woman" who lived in the upper world peered through a hole in the sky and fell through to an endless sea. The animals saw her coming, so they took the soil from the bottom of the sea and spread it onto the back of a giant turtle to provide a safe place for her to land. This "Turtle Island" is now what we call North America.

Sky woman had become pregnant before she fell. When she landed, she gave birth to a daughter. When the daughter grew into a young woman, she also became pregnant (by the West wind). She died while giving birth to twin boys. Sky Woman buried her daughter in the "new earth." From her grave grew three sacred plants-corn, beans, and squash. These plants provided food for her sons, and later, for all of humanity. These special gifts ensured the survival of the Iroquois people (2)

Corn

Corn is considered the most important of all Native American crops. Originating in South America and Mexico, corn was introduced during the Mississippian Period (600 A.D. to 1450 A.D.) to North American tribes via an intricate series of trade networks. Corn, beans, and squash combine to create a nearly perfect meal loaded with essential vitamins and minerals (2). In addition to its nutritional values, all Native American tribes that grew corn considered it a sacred and spiritually valuable plant.

Varieties

Choosing the right varieties of corn is essential to the success of a Three Sisters garden. The tall, sturdy heirloom varieties work best because they are most capable of supporting the beans. There are a number of Native American heirloom corn varieties to choose from. Traditionally, most of the corn grown by Native Americans is dry field corn, which is used in flour production. Dry field corn is harvested late in the season when the ears have dried on the stalk.

Dry field corn is divided into three categories, *dent, flint*, and *flour* corns. Dent corns are adapted best to the Southeast and the Midwest. Dent corn has a distinctive dimple-like

dent on top of the kernel when it is fully dried. A dent corn that grows well most anywhere in the United States is the **Cherokee Blue and White** of the Southeast. **Reid's Yellow Dent** is also widely adapted. **Bloody Butcher** produces blood-red ears of corn on stalks that can reach from 10 to 12 feet (2, 3).

Flint corn grows best in the northern plains region. The kernels of flint corn do not shrink when they are dry. A popular flint corn is **Indian Ornamental** with colors ranging from purple to yellow. Two popular flint corn varieties are **Fiesta** and **Little Jewels**. **Little Jewels** is a unique, "mini" ornamental with four-inch-long, multi-colored ears and purple husks (3).

Flour corns usually have thinner-shelled kernels filled with soft white starch. Flour corns were developed in the arid Southwest. They are less likely to succeed in cooler northern regions with short growing seasons and in moist, humid areas where they are susceptible to a fatal rust disease. **Hopi Pink** is a short, drought-resistant corn, with kernels that range in color from cranberry to light pink. This variety has plump, thin-shelled kernels that grind easily into fine flour. A flour corn that works well in northern gardens is **Mandan Bride**. This variety is also drought-tolerant, with red, blue, yellow, pink, and purple spotted kernels (3).

Corn can be harvested earlier in the season when it is still "green corn." Green corn is harvested when the corn is still in the "milk" stage, when the kernels are at their sweetest and can be eaten fresh. Varieties that are sweet when young are **Blue Clarage**, **Bloody Butcher**, and **Black Mexican/Iroquois**. Flour corns are usually not eaten in the green corn stage. Two exceptions to this rule are **Anasazi** and **Mandan Red**. (3). See Table 1.

Table 1: Colorful Corn Varieties

Variety	Type	Color	Can Be Eaten Fresh	Comments
Anasazi	Flour	Multi	Yes	Ancient Southwestern variety, drought-tolerant
Beasley's Red Dent	Dent	Red		Heirloom from Indiana
Black Mexican/Iroquois	Sweet	Blue-Black	Yes	Smaller variety from the Northeast
Black Aztec	Sweet	Blue, Black, Purple	Yes	Originated from southern Mexico
Bloody Butcher	Dent	Red	Yes	Northeastern united States, Virginia area
Blue Clarage	Dent	Blue	Yes	Ohio/West Virginia
Bronze-Orange	Sweet	Bronze-Orange	Yes	Selected by Dr. Alan Kapuler
Cherokee Blue & White	Dent	Blue and White	Yes	Grown throughout North America
Cherokee White	Flour	White		Grows 12-15 ft. Tall
Fiesta	Flint	Multi		Developed in New Hampshire
Hopi Pink	Flour	Pink		Short, drought-tolerant, Southwestern variety

Hickory King	Flour	Yellow		12 ft. Tall Heirloom
Indian Ornamental	Flint	Multi		Widely grown by North American Indians
Little Jewels	Flint	Multi		4-inch long corn developed in New Hampshire
Mandan Bride	Flour	Multi		Originated from Mandan tribe
Mandan Red	Flour	Reddish-Black	Yes	Developed in Washington
Oaxaca Green	Dent	Green		Southern Mexico, makes green flour
Rainbow Inca	Sweet	Multi	Yes	Developed by Dr. Alan Kapuler
Rainbow Indian	Flour	Multi		Developed by Dr. Alan Kapuler
Texas Honey June	Sweet	Yellow	Yes	Heirloom, sturdy 7-8 ft. Stalks
Tuscadorea/Iroquois White	Flour	White		Tall, Iroquois variety
*Adapted from Amazing Maize! Cultivate Colorful Corns by Eric Rosenthal (3).				

Beans

Beans provide a high-quality protein food source that combines well nutritionally with corn. Beans also play a valuable role in the Three Sisters garden. Through a symbiotic relationship with rhizobium bacteria, beans help to take nitrogen from the air and convert it into a usable form for next year's crop.

Varieties

Pole beans are best adapted to directly climb the corn stalk as opposed to sending runners across the ground. The **Scarlet Runner** variety is a popular heirloom pole bean that is famous for its large clusters of bright red flowers. **Genuine Cornfield** consistently produces in the heat of Southern summers. **True Cranberry**, a dark red bean with a meaty texture and a nutty chestnut-like flavor, also performs well in the South and in the Northeast. **Cornfield**, unrelated to **Genuine Cornfield**, does well in the Pacific Northwest because it matures before the fall rains come. A favorite in the arid Southwest is **Hopi Purple**, a purple bean with black crescent moon stripes (2).

Squash

Growing low to the ground, squash and pumpkin serve as living mulch. The large leaves block out much of the sunlight, thus reducing weed seed germination. Allelopathy may be an additional factor in weed suppression(4). (Allelopathy refers to chemical secretions from a plant which have adverse or phytotoxic effects on some weed species).

Varieties

Most any variety of squash will work in a Three Sisters garden. In addition to the contemporary hybrid varieties, there are still some traditional varieties available. In the Northeast, the Penobscot and Abenaki still grow **Long Pie** (a.k.a. **Indian** or **Golden Oblong**) pumpkin. This pumpkin looks like a fat zucchini with the texture of a pumpkin. It has a long storage life and usually doesn't turn orange until after it is harvested. A disease-resistant variety suited for the Southeast is the **Connecticut Field**. This very vigorous Native American heirloom yields large, bright orange pumpkins. **Mayo Blusher** is a very sweet, pale gray pumpkin that blushes pink when ripe. **Cushaw** is a gourd-like squash that has been grown in the Southwest by the Pueblo Indians for storage containers since pre-Columbian times. Other varieties of squash also grow well in the Southwest depending on the amount of moisture available (2).

Cultivation and Planting Designs

Planting designs and cultivation practices vary according to climatic region. Garden styles were developed mainly out of practical considerations, such as moisture availability, climate, and the length of the growing season. The Wampanoag garden style works well east of the Mississippi. Hidatsa gardens were developed to thrive in the climate of the northern Plains, while the Zuni waffle garden was designed to conserve water in the arid Southwestern climate.

Wampanoag Three Sisters Garden

It was the Wampanoag gardens that enabled the early settlers of Jamestown to survive and thrive in the New World. Squanto was a Wampanoag who "taught the newcomers to plant maize in little hills and fertilize each mound with an alewife, a species of fish" (5). With this efficient and intensive gardening style, each family could sustain their needs on about one acre of land. Many of the tribes of the Northeast, including the Iroquois, used the Wampanoag garden design. Planted without plowing or tilling, the traditional Wampanoag garden includes corn, beans, squash, and sunflowers. The corn and beans are planted in mounds, with squash planted between the mounds. The sunflowers are planted along the north edge of the garden, so that they do not cast a shadow on the other crops (see Figure 1). When the sunflowers have bloomed and the squash and beans have flowered, the Wampanoag Three Sisters garden becomes a stunning cluster of red, yellow, and white flowers against a textured backdrop of shimmering greens.

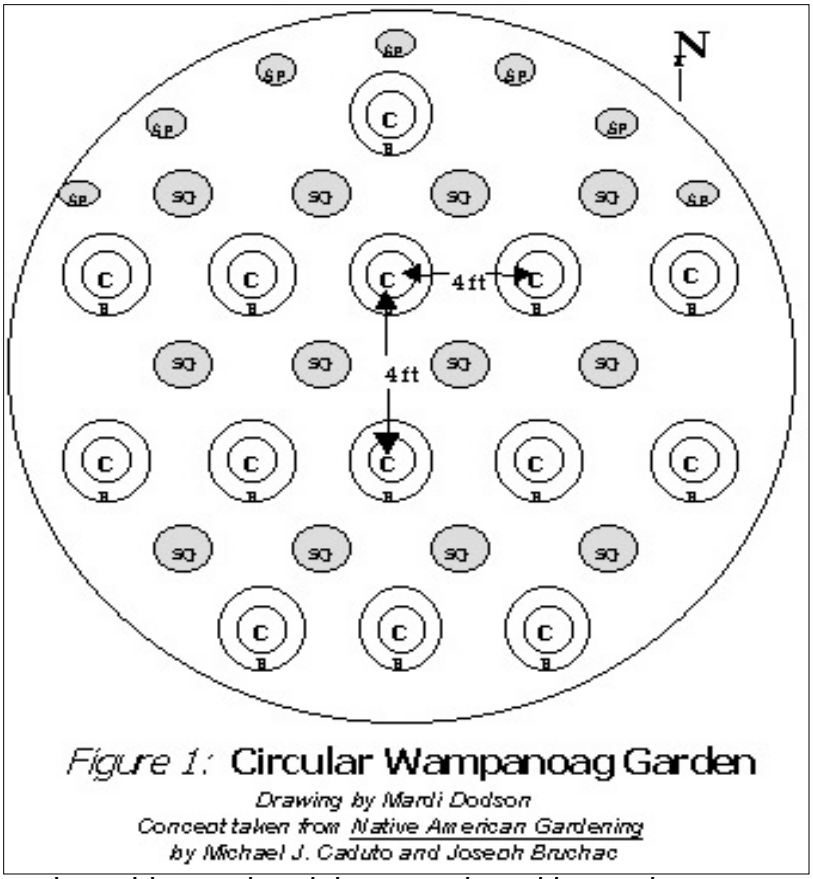
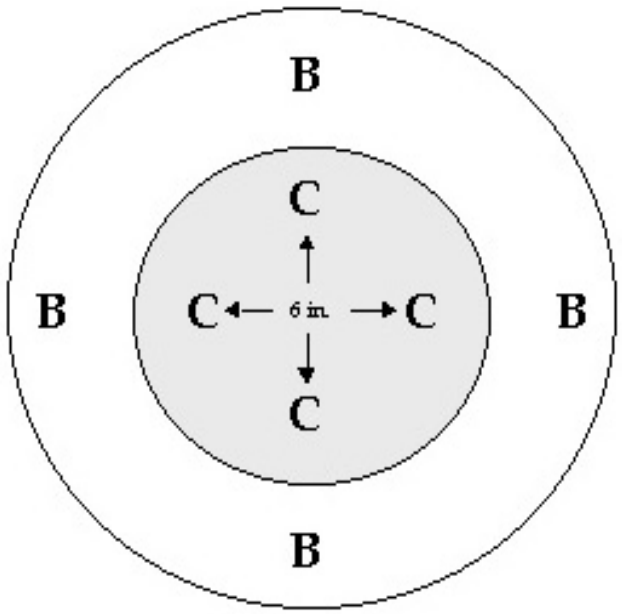


Figure 1: Circular Wampanoag Garden
Drawing by Mardi Dodson
Concept taken from Native American Gardening by Michael J. Caduto and Joseph Bruchac

First, the raised corn and bean mounds must be constructed. These small mounds are laid out in rows with 4 feet between the *centers* of the mounds (see Figure 1). Each mound is about 4 inches high, with a wide base (about 18 inches in diameter) that narrows to a flattened top (about 10 inches across). To conserve moisture, a depression with a lip may be formed at the top of each mound (6). The finished mounds have a remarkable resemblance to miniature moon craters.

Figure 2: Wampanoag Corn & Bean Mound



Corn is planted 6 inches apart in the flat top of the mound. Beans are planted halfway down the slopes on the sides of the mound.

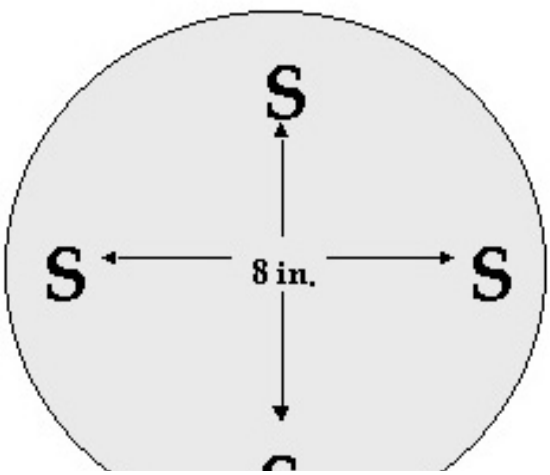
Drawing by Mardi Dodson
Concept taken from Native American Gardening by Michael J. Caduto and Joseph Bruchac

When the mounds are ready, plant four corn seeds about 6 inches apart and 3 inches deep in the top of each mound. Once the corn has grown to a height of 4 inches or more, plant four beans seeds halfway down the slopes on the sides of each mound (see Figure 2). Allow the bean vines to entwine themselves around the cornstalks for support. The bean vines may be pruned if they get too aggressive (6).

Squash seedlings are planted at the same time as the beans. Construct rounded mounds 3 inches high and about 1 foot across at the base. The squash mounds are staggered *between* the mounds of corn and beans (see Figure 1). Traditionally, four seedlings are planted in the top of each mound.

The seedlings are arranged to represent each of the four sacred directions (see Figure 3). Both winter and summer varieties are planted, including pumpkins, acorn squash, and summer crookneck squash (6). Sunflower seeds are planted at the same time as the corn. The smaller-flowering common sunflower, *Helianthus annus*, is traditionally grown in a Wampanoag Three Sisters garden. The sunflower mounds are located at the north edge of the garden (see Figure 1). The mounds are spaced about three feet apart from center, with

Figure 3: Wampanoag Squash Mound



three seeds planted (one seed per hole) atop each mound. The sunflowers seeds are traditionally harvested after the first frost (6).

Drawing by Mardi Dodson
Concept taken from Native American Gardening
by Michael J. Caduto and Joseph Bruchac

Hidatsa Gardens

In the northern plains, the Hidatsa, Mandan, and Arikara peoples gardened along the floodplain of the Missouri River in what is now called North Dakota. Most of the tribes in this region used the Hidatsa garden design (see Figure 4).

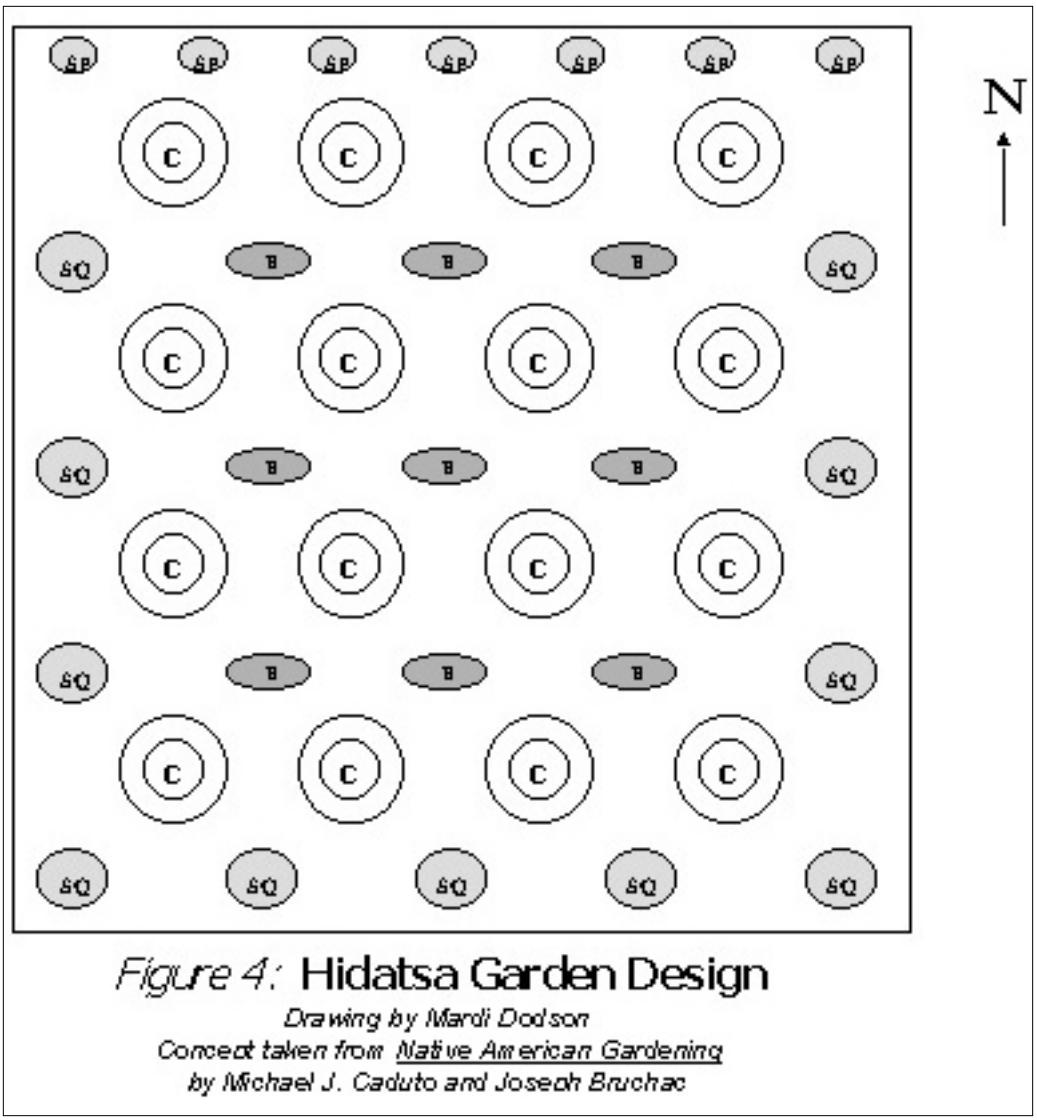


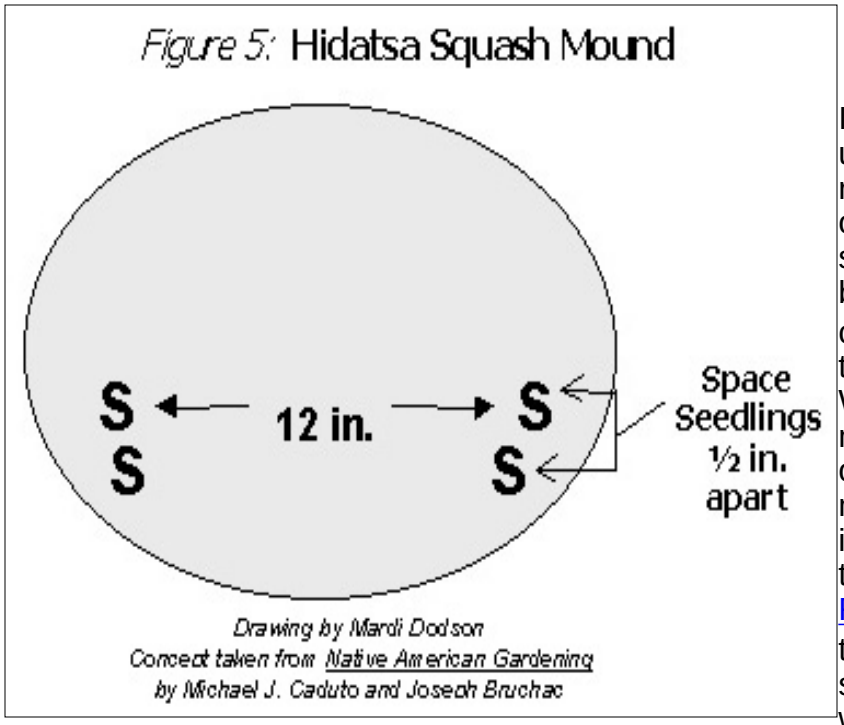
Figure 4: Hidatsa Garden Design

Drawing by Mardi Dodson
Concept taken from Native American Gardening
by Michael J. Caduto and Joseph Bruchac

Hidatsa gardens are designed to have alternating, staggered rows of corn and beans, with sunflowers growing along the north edge of the garden. Squash is planted after every fourth row of corn and beans and around the east, south, and west edges of the garden (6).

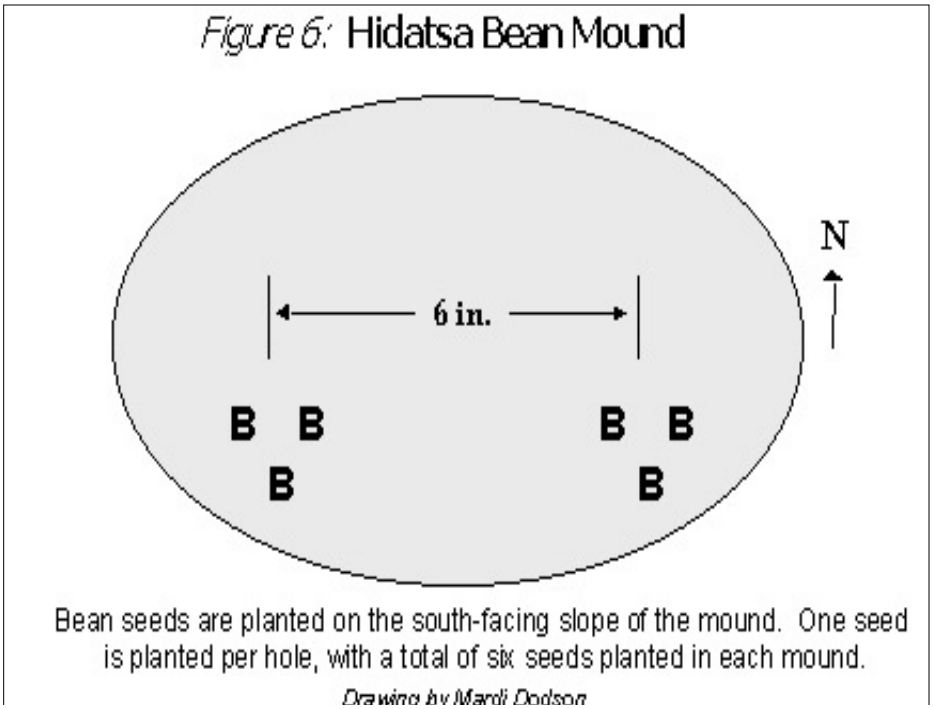
Sunflowers are planted as soon as the threat of frost has passed. As in the Wampanoag garden, three sunflower seeds are planted in small mounds 3 feet apart along the north edge of the garden. The Hidatsa garden differs from the Wampanoag garden when it comes to seed arrangement-all three seeds are planted in one hole. Hidatsa varieties of sunflower produce black, red, white, and striped seeds (6).

Plant squash indoors in peat pots or seed flats when the sunflowers are planted in the garden. Before planting in the garden, prepare the squash mounds (about 15 inches across at the base), with 4 feet between the centers of the mounds. The squash mounds are located along the east, west, and south edges of the garden in alignment with the rows of beans (see Figure 4). Squash seedlings are usually transplanted when they are about 4 inches tall and have put on their first set of true leaves (about two weeks after the corn is planted). To protect them from the heavy spring rains, four seedlings are planted on the sides of the mound in sets of two, 12 inches apart (see Figure 5) (6).



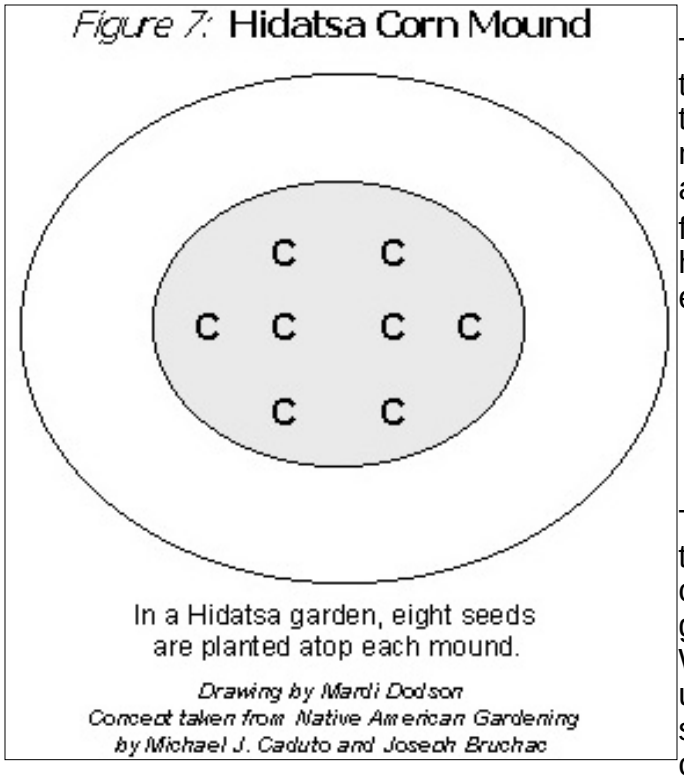
In the Hidatsa garden, there are usually four corn mounds per row of corn. Note that the rows of corn are in alignment but are staggered in comparison to the beans (see Figure 4). Hidatsa corn mounds are constructed in the same way as the Wampanoag corn and beans mound. The differences are that only corn is planted in these mounds and eight seeds, instead of four, are planted in the top of each mound (see Figure 6). Growing corn together in bunches offers extra support and protection from wind and rain damage.

Hidatsa flint corn is planted in May in North Dakota when the leaves of the Gooseberry shrubs have emerged and fully formed. Corn is planted a week or two after the sunflowers have been planted. This flint corn is a semiarid variety with a growing season of about 70 days. It is advisable to research which corn variety works best for your zone and climatic conditions (7). Beans are planted at the same time as corn. In a Hidatsa garden, beans are



Concept taken from Native American Gardening
by Michael J. Caduto and Joseph Bruchac

planted separately from the corn in their own mounds. The bean mounds are located between the rows of corn in a staggered, alternating pattern (see Figure 4). The mounds are rounded ovals, about 4 inches tall by 7 inches wide by 14 inches long. Traditionally, two people worked together to plant beans. The first person made six holes in the south-facing slope of the bean mound.



This is done in one swift motion by thrusting both hands into the soil with the thumb and first two fingers extended to make two sets of holes spaced 6 inches apart (see Figure 7). The second person follows behind and plants one seed in each hole. A total of six seeds are planted in each bean mound (7).

Zuni Waffle Garden

The Zuni live in the Four Corners area of the Southwestern United States. This arid climate at altitudes over 7,000 feet makes gardening a special challenge. The Wampanoag and Hidatsa garden designs use raised mounds to keep the root systems from being waterlogged. In contrast, the focus of this garden is *water conservation*. The waffles are about 12 feet by 12 feet. Each individual square is indented and surrounded by a high rim. In each square, a single crop or combinations of crops may be planted (see Figure 8). This garden design will work anywhere in the country where dry summer conditions are experienced.

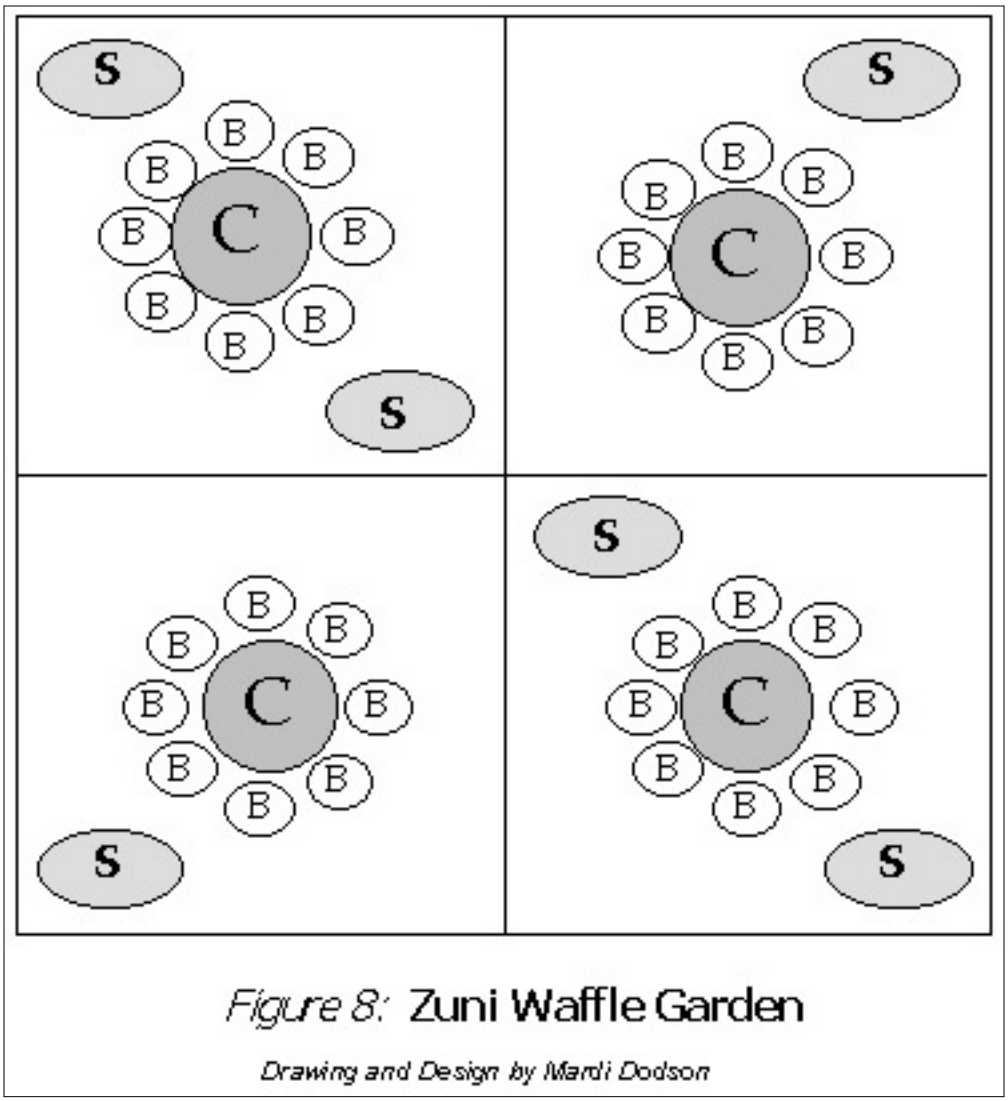


Figure 8: Zuni Waffle Garden

Drawing and Design by Mardi Dodson

Traditionally, the crops are planted intensively with five to eight corn seeds in each hole to create clumps of corn similar to those in the Hidatsa garden. Corn seeds are planted 4-8 inches deep in light sandy soils and about 4 inches deep or less in heavier clay soil. Beans and squash have the same planting depths and spacing requirements as corn (8). The same number of beans (4-8 seeds) are planted around each clump of corn, one seed per hole. Only one or two squash plantings (4-8 seeds in each hole) are added to each waffle (see Figure 8) (3). As with the other two designs, sunflowers may also be planted along the edges of the Zuni Waffle garden. *Helianthus maximilianii*, a small sunflower with flower heads about 3 inches wide, is most commonly grown in the Southwest (9).

Summary

Native American tribes of North America have made enormous contributions to the foods we eat today. The dynamic trio known as the *Three Sisters* not only thrive when they are planted together, they offer a well- balanced, nutritious meal. Over the centuries, many plant varieties and gardening styles were developed for each major climatic region. The Wampanoag (Northeast and South), Hidatsa (Plains), and Zuni waffle garden (Southwest) offer a range of gardening styles to accommodate most growing conditions found in North America.

Corn, beans, and squash have a unique symbiotic relationship in a Native American garden. Corn offers a structure for the beans to climb. The beans, in turn, help to replenish

the soil with nutrients. And the large leaves of squash and pumpkin vines provide living mulch that conserves water and provides weed control. This ancient style of companion planting has played a key role in the survival of all people in North America. Grown together these crops are able to thrive and provide high-yield, high-quality crops with a minimal environmental impact.

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By George Kuepper & Mardi Dodson
NCAT Agriculture Specialist & Project Intern
July 2001

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Fact File Self-sufficiency guide

This summarises how much to grow to feed a family of two adults and three children. Each of the rows is 4.5M (15ft) Long. Also included is advice on how much to harvest for each meal. Remember that it is always better to pick your crops fresh for each meal and eat them as soon as possible after harvesting. Leaf vegetable, in particular; begin to lose some of their nutritional value immediately they are harvested. If you have a surplus of a particular crop, don't allow it to get old and tough: gather it and freeze it while it is still young and tender or give it to friends.

Beans

Broad: 3 rows (plus one for the freezer, if needed), 45 cm apart, seeds 30cm (1ft) apart. Pick 340g (3/4lb) of pods when young for each adult, 226g (1/2lb) for each child. When pods have filled out, pick 226g (1/2lb) for each person.

French: 5 rows, 30cm (1ft) apart, seeds 25cm (10in) apart. This should also give you a surplus for freezing. Allow 170-226g (6-8oz) per person.

Runner: 1 double row, 60cm (2ft) apart, when grown up a support. On the flat, 4 single rows, 60cm (2ft) apart. Seeds 30cm (1ft) apart. Pick 226g (1/2lb) per person.

Beetroot

1 row for summer salads gives 30-40 small beet; 2 rows, 30cm (1ft) apart, for autumn and winter use.

Broccoli, Purple Sprouting

1 row of six plants. Pick without any large leaves, allowing 170gm (60z) per person.

Brussels Sprouts

6 rows, 45cm (18in) apart, plants about 60cm (2ft) apart, but distance varies according to variety. Aim for 20 early, 20 mid-season and 20 late maturing plants. Pick 26g (1/2lb) per person.

Cabbages

Spring: 3 rows, 45cm (18in) apart each way, some to eat as spring greens, allowing others to heart up. Allow 226gm (1/2lb) per person of greens.

Summer, autumn: 2-3 rows 9giving 20-25 heads, depending upon size), 45cm (18in) apart each way on average. For the family of five you will need a cabbage trimmed of coarse outer leaves weighing 1.10 - 1.36kg (2.5 - 3lb).

Winter: 3 rows, plants 45cm (18in) apart each way to give about 30 heads, Each with a finished weight of 1.36 - 1.8kg (3 - 4lb).

Carrots

Early: 2 rows, 15cm (6in) apart, do not thin. Pull 6-9 carrots per person for earliest feeds, 4-5 when larger.

Maincrop: 2 rows, 20cm (8in) apart. Allow 170g (6oz) per person.

Cauliflowers

Spring and summer - 15 heads; autumn - 12 heads; winter - 12 heads. Winter 75cm (2.5ft) apart each way, others 60cm (2ft) apart each way, except for mini-caulis. A 1kg (2lb) head with leaves trimmed will serve five people.

Celery

1 row, 1m (3ft) wide with about 25 plants staggered and 15 - 22cm (6-9in) apart. For braising you will need 3 heads for six people.

Courgettes

6 plants, 1m (3ft) apart each way. Allow 226g (1/2lb) per person.

Kale

3 rows, 60cm (2ft) apart each way. Pick while young allowing 171g (6oz) per person.

Leeks

3 rows, 30cm (1ft) apart, 25cm (10in) between plants. Allow one well grown leek per person.

Lettuce
Cos or cabbage types, 2 rows 30cm (1ft) apart, sown half a row at a time for succession, thinned 15-22cm (6-9in) apart. Depending upon variety. Pick as required for salad or sandwich use.

Marrows
4 plants of bush type, 1m (3ft) apart. A 1.3kg (3lb) marrow is sufficient for the family.

Onions
Spring: 1row, sown a third at a time for succession.

Maincrop: 450g (1lb) of onion sets consists of about 100 bulbs. Place 10cm (4in) apart in rows 30cm (1ft) apart to give a finished crop totalling 22.7-36.3kg (50-80lb) which will see you through the winter and spring.

Parsnips
2 rows, 20cm (8in) apart 7.5cm (3in) between plants. Allow about 340g (3/4lb) of untrimmed roots per person when used as a main vegetable.

Peas
6 rows, (3 early, 3 maincrop), 1m (3ft) between rows, 7.5cm (3in) between seeds. This should give a decent surplus for freezing. For early varieties picked young allow 450g (1lb) of pods per adult. For maincrop, picked with full pods, allow 280g (10oz) per person.

Potatoes
3kg (6.6lb) of seed potatoes for every 3 rows produces 22.7-31.7kg (50-70lb) of earlies and up to 45kg (100) of second early and maincrop varieties, but a lot depends upon the variety and the season. Allow 170gm (6oz) of earlies, and 226g (1/2lb) maincrop (unpeeled) per person.

Radishes
2 rows, sown thinly, half a row at a time for succession, 15cm (6in) between rows.

Shallots
Pickling, 1 row, bulbs 30cm (1ft) apart. Cooking, 2 rows, bulbs 30cm (1ft) apart each way.

Spinach
Summer, 3 rows, 30cm (1ft) between plants, 37.5cm (15in) between rows. Winter, 2 rows, spacing as for summer. Allow about 141g (5oz) of leaves picked young with a minimum of stalk.

Swedes
2 rows, seeds 15cm (6in) apart, 45cm (18in) between rows. Allow 280g (10oz) of untrimmed roots per person when used as a main vegetable.

Tomatoes
Outdoor bush type, 6 plants, 1m (3ft) apart each way. Outdoor standard type, 6 plants, 45cm (18in) apart in row.

Turnips
Summer, 2 rows, 25cm (10in) apart, seedlings thinned to 10cm (4in) apart. Winter, 2 rows, 30cm (1ft) apart, seedlings thinned to 15cm (6in) apart. Allow 226-280g (8-10oz) of untrimmed root per person.

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Preserving Food Safely

Full text database on canning, freezing, drying of food. Based on USDA Complete Guide to Home Canning. (Last full revision in September of 1994) Use the keyword 3 to see a complete listing of all keywords in the database.

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See the Forum Help Page.

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Welcome to the Gardening Launch Pad! This list is friendly to the Home Gardener. Make The Gardening Launch Pad your starting point for all your electronic gardening needs. Number of gardening links 4978, 95% of these links are content links not commerical links..Links are added every month. See the Whats New Page for monthly updates.
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Feature Sites

The Gardening Guru The horticultural help you have been looking for is here just for the asking. I am the Gardening Guru, here to answer your most perplexing gardening questions, and to teach you how fun and enjoyable gardening can be! I have numerous years of experience in the horticulture field, from owning my own landscaping company, to wholesale/retail/distributor general manager of a landscape supply company, to Landscape Supervisor of an 81 acre county park, to currently Executive Director of the Reeves-Reed Arboretum in Summit, New Jersey.
Featured Sites of the Past

Feature Tip

Help your lawn resist heat and drought - Cutting your lawn too short makes it difficult for the grass to stand up to heat and drought. The best height for a healthy lawn is 2-3 inches. Watering lightly encourages shallow roots systems, so water less frequently but deeply for deep, sturdy roots that will have a better chance of withstanding dry periods.
Past Gardening Tips

Feature Humor/Quotes

When a man is described as having a green thumb, it doesn't necessarily mean he's a great gardener.

It could also mean he's a rotten painter!

Feature Article

Grafting Fruit Trees It's a seemingly magical process by Nan Sterman One of my favorite childhood memories is of picking ripe, juicy nectarines from my parent's backyard trees. They were homely little fruits, but they were sweet and mellow, and they melted in my mouth. Last summer, my own children harvested nectarines from that tree in our backyard. How can that be? The fruits came from grafted fruit trees.

Featured Articles of the Past

The Categories

African Violets
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Personal Gardening Pages
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Terrariums
Trees
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Look at the **new releases** at Barnes & Noble in **Home and Garden: New Releases**

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backyard birds link

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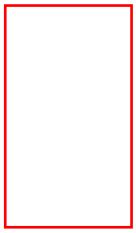

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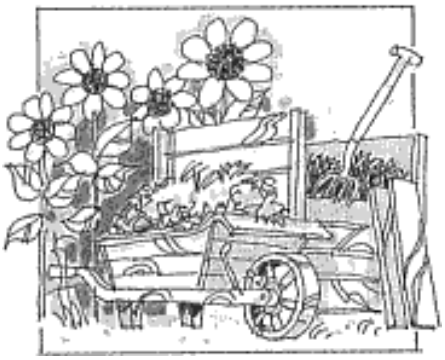
How to ... practical advice from HDRA

How to make compost



Making compost from garden and household waste is one of the best things any gardener can do. It's easy and costs very little in time or effort.
Making compost will help you reduce pollution - cut down that landfill! Your plants will grow healthier and look happier for it. It will save you money on fertilisers too.

Read on to find out:

- What can I compost?
- How do I make my compost?
- Composting hints & tips
- Composting questions answered

The whole document is available here in a Printer friendly version

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Your Harvest Guide
It's harvest time! We've gathered 80 tips for picking your favorite vegetables at their best. Plus, we tell you how to can, pickle, freeze, and dehydrate your harvest. And we've got heavenly harvest recipes.

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How does our garden grow?
This week: Oriental vegetables in the *Organic Gardening* test garden.

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Please set your browser to:

http://compost.css.cornell.edu/Composting_homepage.html

HowToCompost.org
Your Compost Resource

Welcome

Interested in the various aspects of composting? Well, you've come to the right place. On our site you will find articles and hundreds of links covering all aspects of composting. Take a look around and let us know what you think.

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Thanks to our new sponsor Mantis, we are back and better than ever! We have a new server, a new forum and a way for everyone to submit links and information.

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We are looking for articles, information, tips, jokes, **ANYTHING** that is about composting.

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From beginners to experts this web site is designed to be a hub for all composting information. No matter what your interest is, you'll find something here worth you time. Our goal is to be the best resource on the internet for composting information.

On our site you will find articles and links covering all topics about composting and organic gardening. We do not discriminate, if you have an composting article or tip please submit the information so we can post it for everyone to enjoy. If you know of a good link to your favorite composting web site or article send it to us!

An interview with Russ Cohn, President of NatureMill

In March we featured the Kitchen Composter by NatureMill in our Take a Look section. We received so many questions and comments we elected to interview the company's President Russ Cohn. The following article includes some of your questions.

The NatureMill

What is the NatureMill?

The NatureMill concept is a revolutionary idea in home composting and as far as we can tell one of the newest ideas for home composting to be introduced in years. The premise is simple, instead of taking your kitchen scraps outside to the compost bin, why not bring the compost bin inside? read more...

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Forum

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THE FORUM
An interactive bulletin board full of good questions, good answers, and lively discussions of all things composting!

Take A Look

Envirolet® Composting Toilets
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Recognition

This site has received praise and recognition from visitors around the world.
See what they have to say

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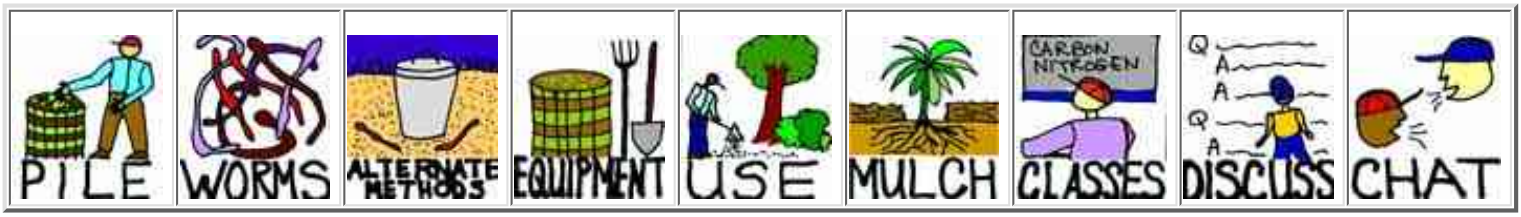

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SITE CONTENTS

- Build a Compost Pile: Basics
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- More on Building a Pile
- Compost Ingredients
- Use Finished Compost
- Leon's Composting

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- In-Soil Ingestion
- Trench Composting
- Mulching
- Sheet Composting
- Compost Toilets

REFERENCES (index)

Web Site Contents provide accurate links if others are out of order

I'm currently updating the web site. This sometimes means moving pages, which leaves links between pages temporarily out of order. Links in the Site Contents will always be working -- that column is to the left on this page -- so you can come to the home page and click to where you want to go. Note: Someone told me they had problems with the Search Engine, so I'm checking that out now.

Compost Tea is Subject of Next Newsletter
Back Issues of Newsletter No Longer Available

Creating Compost Tea is the subject of our next newsletter. To receive, subscribe today! For more information on our newsletter

Past issues of the newsletter are no longer available, but I have some new information sources in the works. These will be published in eBook format and can be read with the free Adobe Reader for pdf files. To be notified when these eBooks are available, sign up on the eBook Notification Sign Up page.

Policy Change for Local Program Listings

In the past, I have listed information for non-profit local Master Composting and

- Glossary
- Calculate C : N Ratio
- FAQ on Composting
- Message Board Archives
- Compost Message Board
- Compost Chat Room

EDUCATIONAL (index)

- Our Newsletter
- Book Reviews
- Teacher Resources
- Master Composter Course
- Hand-outs

WHY WE COMPOST (index)

- What is Compost?
- Why Not Throw It Away?
- Benefits of Healthy Soil

PAST SURVEYS

- Coffee Grounds Survey
- Leaf Thief Survey

WEB SITE INFO (index)

- About Us
- Advertising Rates
- Disclaimer
- Awards
- Contact Us
- Netlinks

COMPOST PILES (index)

Home Composting classes and programs on the site. This section will remain on the site. However, I am changing to a format where the **web site** for each program is listed rather than the actual information.

This change is being implemented because the vast majority of programs fail to send updates as they are required to do. Amazingly, some later send rude, often nasty emails slamming us because their listing is out of date (even though it's out of date because THEY didn't provide information when it changed). I feel there is a far greater chance that they will keep their own web sites up to date, so if I link directly to them, you should get good contact data and class schedules.

Congratulations Scotland!
Congratulations to Scotland on the formation of their first Master Composter program covering the northeast of Scotland; Aberdeenshire and Moray. Check them out at www.scraps.org.uk. They are a not-for-profit program, have two full time project officers and are hoping to recruit and train over 100 master composters over the next year. Further details are available from the website, or by e-mail from info@scraps.org.uk

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Resources in New Zealand
There are some great online resources for New Zealand composters! We will soon have a separate page in our Local Programs listings. Until then check out these links:

New Zealand Waste Strategy
Christ Church City Council Solid Waste Info
Aukland Regional Council Waste and Recycling

Visit the Compost Message Board for Answers to your Compost Questions!

URL: http://www.mastercomposter.com/index.html

Home Page URL: http://www.mastercomposter.com
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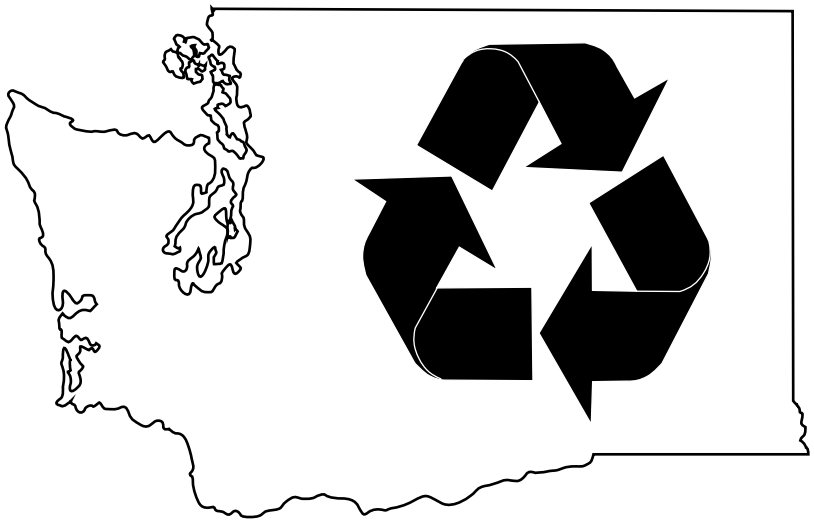
Compost! Composting is a great way to help the environment. If you care enough to read the fine print, you care enough to compost.



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Craig G. Cogger
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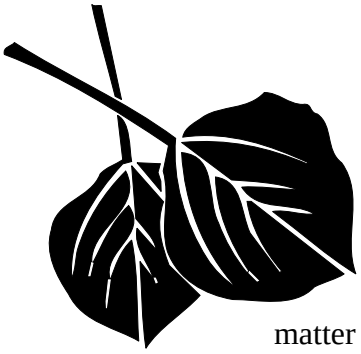
COLLEGE OF AGRICULTURE & HOME ECONOMICS

BACKYARD COMPOSTING



BACKYARD COMPOSTING

Craig G. Cogger and Dan M. Sullivan

Gardeners have long made and used compost because of the way it improves garden soil. Today, we also compost plant and vegetable matter because it is an important way to reduce the amount of waste that is burned or dumped in landfills. Yard wastes and vegetable scraps can make up as much as 20% of our household garbage. Composting effectively recycles that waste.

THE SCIENCE OF COMPOSTING

The cycle of growth and decay. Composting carries out part of the earth's biological cycle of growth and decay. Plants grow by capturing the sun's energy along with carbon dioxide from the air and nutrients and water from the soil. When plants (and the animals that eat them) die, they become raw materials for the composting or decay process. Microorganisms, fungi, insects, worms, mites, and other creatures convert the carbon from dead plants into energy for their own growth, releasing carbon dioxide into the air. Similarly, they recycle the nutrients from the decaying plants into their own bodies and eventually back into the soil. Other plants and microorganisms use the carbon and nutrients released by the composting process, and the cycle begins again.

The material that remains from the decay process is similar to soil organic matter. It holds water and nutrients in the soil, and makes the soil more porous and easier to dig.

Fast or hot composting. We can manipulate the decay process to make it proceed quickly. We do this by balancing food, water, and air in the compost pile to favor the growth of thermophilic (high-temperature) microorganisms. One byproduct of microbial activity is heat. When conditions are favorable for high-temperature microorganisms, compost piles heat rapidly to 120° to 150°F. This temperature range kills most weed seeds and pathogens (disease organisms), but does not kill mycorrhizae (beneficial fungi that help plant roots absorb nutrients). Once the hot phase is complete, lower-temperature microorganisms, worms, insects, and other invertebrates complete the decay process.

Slow composting. If we do not maintain ideal conditions for hot composting, microorganisms will still break down the wastes. Decay will be slower, cooler, and less effective at killing weed seeds and pathogens.

MANAGING THE DECAY PROCESS

You can affect the speed of the composting process and the quality of the compost product by managing the factors described below.

Food (raw materials). For fast composting, the initial mix must have the proper moisture and air content, and organic materials that provide a rich food (energy) source for bacteria. A list follows of some materials commonly used in making compost. They are separated into "energy" materials, "bulking agents," and "balanced" materials.

COMPOST RAW MATERIALS TABLE

BULKING AGENTS

(LOW MOISTURE, HIGH POROSITY, LOW NITROGEN)

- WOOD CHIPS
- SAWDUST
- GRASS HAY
- WHEAT STRAW
- CORN STALKS

ENERGY MATERIALS

(HIGH MOISTURE, LOW POROSITY, HIGH NITROGEN)

- GRASS CLIPPINGS
- FRESH DAIRY, CHICKEN OR RABBIT MANURE
- FRUIT AND VEGETABLE WASTE
- GARDEN TRIMMINGS

BALANCED RAW MATERIALS

(LOW TO MEDIUM MOISTURE, MEDIUM POROSITY, MEDIUM NITROGEN)

- GROUND TREE AND SHRUB TRIMMINGS
- HORSE MANURE AND BEDDING
- DECIDUOUS LEAVES
- LEGUME HAY

Energy materials provide the nitrogen and high-energy carbon compounds needed for fast microbial growth. If piled without bulking agents, these materials usually are too wet and dense to allow much air into the compost pile. When you open the pile, it will have a foul, "rotten egg" smell.

Bulking agents are dry, porous materials that help aerate the compost pile. They are too low in moisture and nutrients to decay quickly on their own.

Balanced raw materials. Some raw materials contain a balance of energy and bulking agent properties. These materials will compost readily without being blended with other ingredients. Examples include horse manure mixed with bedding, spoiled alfalfa hay, and deciduous leaves. These materials are handy for ensuring the success of hot compost piles.

Mixing bulking agents with energy sources provides the right balance of moisture, air and nutrients for rapid composting. **A mixture of one part energy source with two parts bulking agent (by volume) usually gives a reasonable mix for rapid composting.**

Particle size. Grinding, cutting, smashing, or chopping raw materials reduces particle size. Small particles have more surface area for microbial activity and are easier to mix. Hot composting requires a relatively uniform particle size of $^1/_8$ to $^1/_2$ inch in diameter. Woody branches that have not been ground often make it difficult to turn a pile. They also decompose very slowly. We suggest grinding or chipping woody branches, or piling them separately.

Mixing. Contrary to advice in many publications, layering is not the best way to build a pile. If all the materials are on hand, mix them thoroughly throughout the pile. If materials accumulate over time, add new materials to the center of the pile. This practice will help aerate the center of the pile, where anaerobic conditions are likely to occur.

Pile size. The pile must be big enough to hold heat. A hot pile decays much faster than a cold pile. Small piles are usually colder, because they have small cores that hold less heat. Small piles also dry out faster. A pile of about one cubic yard is big enough for year-round composting, even in cold-winter areas.

Moisture. All materials in the pile must be moist, but not soaking wet. The mixed material should feel moist, but you should not be able to squeeze water out of it with your hands. At dry times of the year, you may need to add water. In rainy winter locations, a pile may not heat up unless you cover it to keep out rainwater. Check moisture when you turn the pile.

Aeration. The microorganisms responsible for fast decomposition need oxygen. In the pile, oxygen is consumed by microbes. The pile needs to be porous to pull outside air into it. Use enough bulking agents to create a porous pile. As the pile decomposes, it settles, reducing aeration. Turning the pile or adding bulking agents improves aeration.

Microorganisms. Raw materials used to form a compost pile usually contain all the microorganisms needed to make compost. You do not need to add soil or compost starters with “special” microorganisms. The best source of microorganisms (if needed) is finished compost.

Nutrients. Just like people, microorganisms need nutrients (such as nitrogen, phosphorus, sulfur) to grow and reproduce. These nutrients occur in the raw materials used in the compost mix. Additional fertilizer from any source (organic or inorganic) usually is not needed. Nitrogen fertilizer may be beneficial for mixes consisting mainly of bulking agents. The best way to add fertilizer is to dissolve it in water and wet the pile with a dilute fertilizer solution. Compost additives such as blood meal and bone meal are simply organic fertilizers; they do not contribute anything magic to the compost pile.

HOW TO MAKE COMPOST

Slow Composting

Employing slow composting is an easy and convenient way to turn yard wastes into a useful soil amendment. It is often the best method for people who do not have the time to tend a hot compost pile. Simply mix nonwoody yard wastes into a pile and let them sit for a year or so. Microorganisms,

insects, earthworms, and other decomposers will slowly break down the wastes. A mixture of energy materials and bulking agents provide the best food source and environment for decomposition (see table).

Add fresh wastes to the pile by opening the pile, placing fresh wastes in the center, and covering them. This helps aerate the pile and also buries the fresh wastes so they do not attract pests.

Fruit and vegetable wastes are particularly appealing to pests, such as flies, rats and raccoons. To avoid pests, bury these wastes within the pile. If you bury the vegetable wastes in the pile and pests are still a problem, you may need to screen the pile or keep vegetable wastes out.

You also can bury vegetable wastes directly in your garden. Dig a hole or a trench about a foot deep, add a few inches of vegetable wastes, mix them with the soil, and refill the trench with soil. Another way to avoid pests is to compost vegetable wastes in a worm bin.

Slow composting does not produce the heat needed to kill many weed seeds. It is best to pull and compost weeds before they go to seed. If you put seeds in the compost pile, be prepared for more weeding.

Fast Composting

If you create and maintain a balance of air, moisture, and energy for the compost microorganisms, they will produce a hot compost that will break down quickly and kill off many weed seeds and disease organisms. Making hot compost takes extra effort, but it produces a high quality product quickly. One method for making hot compost is described below:

Building the Pile

Step 1. Collect enough material to make a pile at least 1 cubic yard in volume (an open pile 5 feet wide at the base by 3 feet high holds about a cubic yard). You need roughly two parts bulking agent to one part energy material (see table). Chop, shred, mow, or smash coarse materials so they will break down faster.

Step 2. Start the pile by adding energy material and bulking agent, and mixing with a pitchfork.

Step 3. Squeeze a handful of the mixed material to check its moisture level. If you can barely squeeze out a drop of water, the moisture level is ideal. If the pile is too dry, add water, and check the moisture again. If it is too wet, mix in some drier material.

Step 4. Continue adding energy material and bulking agent, mixing, and checking moisture until the pile is built.

Piles vs. Bins

You do not need a bin or other container to make compost. Piles work well. Some people prefer containers because they look neater, or because it is easier to shield them from pests. Containers can be simple or fancy. Make them from materials such as old pallets, lumber, mesh fencing, or cinder blocks. For hot compost, each bin should be about 3 feet by 3 feet by 3 feet in size. Avid composters often have three bins: two for turning, and one for curing compost.

Turning the Pile

Use a pitchfork to turn the pile weekly, and add water when needed. Turning improves the porosity of the pile and speeds the biological decay. Turning also mixes material from the outside of the pile into the hot center. Cover the pile during rainy periods so it will not get too wet.

Curing Phase

After initial mixing, a regularly turned pile usually stays hot (120° to 150°F) for several weeks to a month. The pile will shrink to about half its original volume during the hot phase. The pile then needs to sit another for 4 to 8 weeks to cure. Temperatures during curing are 80° to 110°F. The compost is ready to use when at least 8 weeks have passed since initial mixing, the pile no longer heats when turned, and the material looks dark and crumbly.

Curing affects the availability of nitrogen and the microbial activity of the compost. Uncured compost may harm some plants. This is most likely when compost is used in potting soil or to start seeds. Curing is less critical when small amounts of compost are worked into soil.

What if my hot compost isn't hot?	*Check the pile.*
• ***If the pile is dry***	*it needs more moisture.*
• ***If the pile is mostly bulking agent***	*it needs more nitrogen. Add energy materials or nitrogen fertilizer.*
• ***If the pile is too wet***	*add more bulking agent. Cover the pile or build a larger pile during the rainy season.*
• ***If the pile has a foul smell***	*it needs more air and less water. Try turning the pile more often or adding more bulking agent.*
• ***If the pile is too small***	*it will not hold the heat.*
• ***If it is cold outside***	*try building a larger pile to hold the heat.*

Sometimes you may have several problems to overcome. If you cannot get the pile to heat, all is not lost, because the pile will still break down by the slow method.

COMPOST USE, HEALTH AND SAFETY QUESTIONS

Are there any plant materials to keep out of a compost pile? If you are composting by the slow method, keep diseased plants and seed heads of weeds out of your compost pile. For any compost, avoid coarse, woody materials because they break down slowly and make the pile hard to turn.

Some plants contain compounds that slow microbial decay. Western red cedar, often used for fence posts because of its resistance to decay, can break down slowly in compost piles.

Can a compost pile catch on fire? A compost pile will only ignite if it has a very hot zone next to a dry zone. Fires will not start in moist piles or in small, backyard piles.

Can I use manure in my compost? Fresh animal manures sometimes contain human pathogens such as *Salmonella* sp. or *E. coli* O157:H7, or parasites, such as *Cryptosporidium parvum*. These pathogens are not taken up into plants, but they can be present in soil that adheres to the surfaces of roots or low-growing leaves and fruits. Careful washing with detergent or peeling will remove most of the pathogens responsible for disease, but some risk remains. Alternatively, thorough cooking will effectively kill pathogens carried on garden crops. If no fresh manure is used in the garden, the risk is minimized.

The greatest risk from manure-borne pathogens is for root crops such as carrots, leaf crops such as lettuce, and fruit crops such as strawberries. The edible part of these crops may become contaminated with soil, the crops are difficult to wash, and they are often eaten raw.

Pathogens in fresh manure typically die off in the environment over time, especially when the manure dries or is exposed to freezing and thawing. The rate of pathogen die-off depends on the type of pathogen and manure, and on environmental conditions such as temperature, moisture, and sunlight. Thorough, high temperature composting kills pathogens, but it is difficult to maintain these conditions in a backyard compost pile. You can limit exposure to pathogens by excluding fresh manure from backyard compost that will be used on fresh garden crops.

It is best to keep dog, cat, and pig manure out of your compost pile and garden. Some of the parasites found in these manures may survive for long periods in compost or in the soil and remain infectious to people.

For more information on animal manure and food safety, refer to *Food Safety Begins on the Farm*, produced by the Cornell University Good Agricultural Practices Program.*

Are herbicides a problem in compost? Although it is a rare occurrence, herbicides from compost have harmed plants grown in soils amended with the compost. Herbicides break down in the environment over time, with the rate of breakdown depending on the type of herbicide and environmental conditions. The higher temperatures and biological activity in a compost pile accelerate the breakdown of most herbicides. Binding with organic matter in the compost also inactivates herbicides. Breakdown and binding reduce the risk of herbicide damage.

Lawn clippings may be a source of herbicides in some home compost piles. The best way to eliminate this source of herbicides is to leave treated grass clippings on the lawn, rather than compost them. Leaving clippings also benefits the lawn. If you suspect herbicides in your compost pile, let the pile sit for a year or more, allowing more time for breakdown and binding. Other options are to reduce herbicide use in areas where you compost the residues, or choose herbicides that break down quickly in the environment.

USING COMPOST IN YOUR YARD

The best part about compost is the benefit it provides for your garden. Mix compost with the soil to add organic matter, or use it as a mulch.

---

*Reference: Rangarajan, A., E.A. Bihn, R.B. Gravani, D.L. Scott, and M.P. Pitts. 2000. Food safety begins on the farm: A grower's guide. Cornell Good Agricultural Practices Program. Cornell University College of Agriculture and Life Sciences.

Amending soil. Well-decomposed, earthy composts are good soil amendments. They make the soil easier to work and create a better medium for plant growth. You can mix 1 to 3 inches of compost into your soil before you plant a garden, lawn, perennial bed, or cover crop.

Mulches. Composts applied to the soil surface help control weeds, conserve water, and protect the soil from erosion. The best time to apply compost mulches is in early summer, after plants are established and the soil has warmed. Later, mulches can be dug or tilled into the soil. When mulching perennial plantings, choose compost made from woody bulking agents, because it decomposes slowly, resists compaction, and slows weed establishment.

COMPOSTING AND THE ENVIRONMENT

Backyard composting reduces the flow of wastes to landfills or burn piles and produces valuable organic matter for the soil at the same time. Composting does all this using a process fueled by the solar energy captured in plant tissue. These benefits are the same whether we compost in carefully tended hot piles, or in neglected slow piles. Backyard composting is a simple, yet important way to improve our communities and the environment.

By Craig Cogger, Ph.D., Washington State University Cooperative Extension Soil Scientist, and Dan M. Sullivan, Ph.D., Associate Professor, Department of Crop and Soil Science, Oregon State University, Corvallis, OR.

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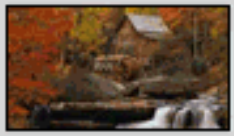

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Soil, Compost and Mulch

This forum is for the discussion of all aspects of soil--including topics like creating a healthy, balanced soil, methods of composting and using mulches effectively.

Before posting a question, please check the FAQ and do a search to make sure it hasn't already been answered.

Instructions on using the forum are provided below.

Related forums: Vermicomposting | Organic Gardening | Permaculture | Integrated Pest Management

Messages:

On-Topic Discussions [Switch to: Gallery | Conversations]

- How thick does the lasagna really have to be? (whine and vent)
  - Posted by: Stella_H z9 Sunset 16 on Mon, Aug 30, 04 at 20:06
- When is Compost 'Overdone'?
  - Posted by: Irentat AZ on Mon, Aug 30, 04 at 18:27
- Compost to redo lawn is too expensive!
  - Posted by: dshuler99 z7 NC on Mon, Aug 30, 04 at 19:29
    - 1 follow-up, posted on Mon, Aug 30, 04 at 21:24
- Ah yes - lobster shells!
  - Posted by: raisemybeds SouthernCT on Sun, Aug 29, 04 at 23:05
    - 8 follow-ups, last one posted on Mon, Aug 30, 04 at 20:27
- A question about tree chippings .....

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- Posted by: raisemybeds SouthernCT on Sun, Aug 29, 04 at 23:12
  - 9 follow-ups, last one posted on Mon, Aug 30, 04 at 19:18

- To mulch or to cover crop...
  - Posted by: Organic_johnny z6b SEPA on Sun, Aug 29, 04 at 8:50
    - 6 follow-ups, last one posted on Mon, Aug 30, 04 at 19:17
- Is the Wheel Easy Gardener any good?
  - Posted by: MomofTwo z6 PA on Sun, Aug 29, 04 at 21:10
    - 3 follow-ups, last one posted on Mon, Aug 30, 04 at 19:07
- What do you do with the %^&* rocks!
  - Posted by: Lowry_Heussler z6 MA on Wed, Aug 25, 04 at 20:44
    - 47 follow-ups, last one posted on Mon, Aug 30, 04 at 17:09
- Last year I mulched with Pea Gravel - Now what?
  - Posted by: soundgarden 8b/9 N.O. La on Sat, Aug 28, 04 at 17:11
    - 4 follow-ups, last one posted on Mon, Aug 30, 04 at 16:48
- General Alfalfa Questions
  - Posted by: Brent_In_NoVA z7 VA on Mon, Aug 30, 04 at 10:56
    - 3 follow-ups, last one posted on Mon, Aug 30, 04 at 16:44
- how to sow cover crops into lasagna garden?
  - Posted by: karnina on Sun, Aug 29, 04 at 6:03
    - 4 follow-ups, last one posted on Mon, Aug 30, 04 at 16:22
- Is composting tomato plants OK?
  - Posted by: Almatt 6A on Mon, Aug 30, 04 at 10:30
    - 6 follow-ups, last one posted on Mon, Aug 30, 04 at 16:09
- pickles in compost?
  - Posted by: MootGirl z7 VA on Sun, Aug 29, 04 at 19:35

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  - Posted by: debbie_ z5 MA on Mon, Aug 30, 04 at 8:04
    - 8 follow-ups, last one posted on Mon, Aug 30, 04 at 15:42
- Why not charcoal ash?
  - Posted by: ShenValleyJoe 6 on Sun, Aug 29, 04 at 10:55
    - 8 follow-ups, last one posted on Mon, Aug 30, 04 at 15:32
- Aeration in AACT
  - Posted by: ChrisB_SC_z7 SC z7 on Thu, Aug 26, 04 at 15:39
    - 11 follow-ups, last one posted on Mon, Aug 30, 04 at 15:27
- snakes
  - Posted by: mrofig 6 IL on Fri, Jul 23, 04 at 10:36
    - 42 follow-ups, last one posted on Mon, Aug 30, 04 at 14:52
- Is my new lawn plan right?
  - Posted by: dshuler99 Z7 NC on Sun, Aug 29, 04 at 11:52
    - 7 follow-ups, last one posted on Mon, Aug 30, 04 at 13:41
- Using bamboo in compost
  - Posted by: ggenovez texas on Mon, Aug 30, 04 at 9:52
    - 7 follow-ups, last one posted on Mon, Aug 30, 04 at 12:57
- Chipper
  - Posted by: YellowMellow_in_NH z5 nh on Fri, Aug 20, 04 at 15:10
    - 28 follow-ups, last one posted on Mon, Aug 30, 04 at 12:42
- Raised rock bed and lasagna ??
  - Posted by: softfurn z7NY on Sun, Aug 29, 04 at 12:37
    - 1 follow-up, posted on Mon, Aug 30, 04 at 12:04
- compost, lawn and weed seeds?
  - Posted by: confounded 6 RI on Thu, Aug 26, 04 at 15:21
    - 9 follow-ups, last one posted on Mon, Aug 30, 04 at 9:31

- Black Soldier Flies
  - Posted by: Pony65 Zone 5 on Tue, Aug 24, 04 at 17:03
    - 15 follow-ups, last one posted on Mon, Aug 30, 04 at 9:10
- Dig or not and other newby compost questions
  - Posted by: Radar2003 UK on Sat, Aug 28, 04 at 13:25
    - 8 follow-ups, last one posted on Mon, Aug 30, 04 at 9:03
- Help! Ants in Mulch
  - Posted by: Dstny1957 z5 IN on Sun, Aug 29, 04 at 23:23
    - 3 follow-ups, last one posted on Mon, Aug 30, 04 at 8:10
- Soil under Pine tree...
  - Posted by: WestchesterGrower on Tue, Aug 10, 04 at 20:50
    - 26 follow-ups, last one posted on Mon, Aug 30, 04 at 6:59
- got a tree trimmed, now have large pile of chips/leaves
  - Posted by: macfairman 10 N. CA on Fri, Aug 27, 04 at 12:36
    - 5 follow-ups, last one posted on Sun, Aug 29, 04 at 23:04
- Need some advice
  - Posted by: Stormys_mom Md on Sat, Aug 28, 04 at 20:50
    - 6 follow-ups, last one posted on Sun, Aug 29, 04 at 23:01
- hardwood vs. pine bark mulch
  - Posted by: KirstenHolm z6 S. OH on Fri, Aug 27, 04 at 19:58
    - 6 follow-ups, last one posted on Sun, Aug 29, 04 at 16:25
- Liquid Gold (aka human urine)
  - Posted by: Bethintokyo Tokyo on Wed, Aug 18, 04 at 21:07
    - 29 follow-ups, last one posted on Sun, Aug 29, 04 at 15:53

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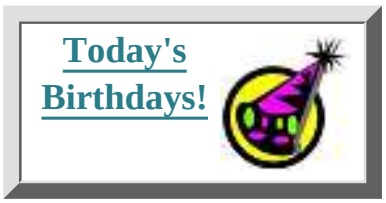

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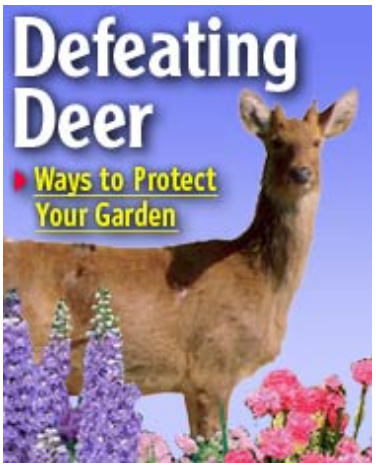

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From the Publisher

Whether you live in a house or an apartment, in the city, suburbs, or the country, composting is the ultimate way to achieve a greener garden and contribute to a cleaner planet. For the veteran composter or the absolute beginner, this no-nonsense, inspirational guide ensures successful composting.

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Books

In Their Own Words: Interviews With Vermiculture Experts
edited by Peter Bogdanov

Do you wonder why there is so much talk about earthworms? Did you know earthworms have value far beyond fish bait? Earthworm castings can have a radical effect on what we grow and the foods we eat.

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Here at last a dozen experts tell you, *In Their Own Words*, why earthworms are our best choice for both managing waste and growing more healthy plants. From scientists to "worm farmers," you'll meet a diverse but informed group of *worm workers* who believe they are ready to usher in a new age of exciting opportunities for thousands of people. Featuring:

- Mary Appelhof
- Jack Chambers
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Explore the new frontier of *vermicomposting* that offers a dual income from accepting raw materials (organic residues) and production of a high-grade soil amendment (earthworm castings).

Whether you are interested in gardening, recycling, soil ecology, or considering a new business in an environmentally friendly but relatively unknown industry, this book will give you dozens of new ideas for discovering the enormous potential of the amazing earthworm

184 pages

#100	**In Their Own Words: Interviews With Vermiculture Experts**	**$15**	Add to Your SHOPPING CART

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Developing A Successful Business Around Earthworms

Presented by Peter Bogdanov at *Vermillennium*, September 2000.

Can I really make a living selling worms?

- Principles VermiCo has employed
- How worm workers can impact the marketplace: a few case studies

- Demographics: How do we know who's out there and what do they want?
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Special Survey of US Vermiculture Operations is included. An examination of 100 Earthworm Growers listed by US State (1996-2001) with observations about rate of industry turnover

See: Slides of several vermicomposting facilities, including: Pacific Southwest Farms (Ontario, CA), Canyon Recycling (San Diego, CA), Ecology Farms (Perris, CA), Yelm Earthworm & Castings Farm (Yelm, WA), Oregon Soil Corporation Continuous Flow Reactor (Portland, OR), American Resource Recovery (Vernalis, CA), Ocoee Florida Biosolids Vermicomposting, Eggen's Vermitech Digester, Windle's South Korean Worm Gin and more!

Includes:

- A 90 minute PowerPoint presentation that can be viewed on any PC.
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Commercial Vermiculture: How to Build A Thriving Business in Redworms by Peter Bogdanov

"With its focus on how to make money raising earthworms, this new book is a welcome source of up-to-date information on the business of vermiculture. Bogdanov puts vermiculture into a historical context, gives basic information about composting worms, tells how to get started, and describes how to set up commercial beds. He covers pests and predators, harvesting, and packaging and shipping. This book is a must for anyone wanting to go into the worm business." Mary Appelhof, *Worms Eat My Garbage*, 2 nd ed., 1997

Commercial Vermiculture looks at the opportunities available for joining a true "growth industry" in vermiculture. The author takes readers through a journey that starts with a look at current efforts in converting tons of organic waste into vermicompost, a high-grade soil amendment. Some landfill diversion sites in California utilize thousands of pounds of redworms to process a variety of organic residues, including yard debris, bio-solids, and the biodegradable fraction of Municipal Solid Waste (MSW). While California's climate allows nearly year-round vermicomposting to occur in outdoor windrows, in-vessel systems are in use in other parts of the country to control key process variables. The emphasis of large vermicomposting sites is upon processing organic waste and production of worm castings for sale. Due to frequent harvesting, worm populations remain fairly steady. In order to start or even expand a vermicomposting operation, redworms are purchased from vermiculture sites, where the emphasis is upon breeding earthworms. Vermiculture operations (worm farms) may not be able to supply the thousands of pounds needed for a large vermicomposting facility.

Frequently asked questions about earthworms are answered in the second chapter, covering such topics as how much do worms eat and how fast will a worm population multiply. In "Getting Started," the author offers suggestions for small, medium and large-size operations. Wooden and concrete bins, pits, and heated, insulated bins are covered. Chapter Four, "Monitoring Conditions in Worm Beds," looks at temperature, moisture, soil pH, and aerobicity. Earthworm feedstocks, including how to find sources of free feedstocks, are discussed in the fifth chapter. Other chapters in the book cover essential information for preparing worms to be shipped to customers.

What is the value of worm castings? A series of quotations from various authorities on the subject of castings is presented in Chapter Nine. In "Earthworms: Yesterday, Today and Tomorrow," the author provides a brief history of the practice of vermiculture, including an inside look at what happened to a million-dollar-a-year worm growing business from the 1970s. The final chapters of this book offer a variety of things that can be done to maximize success and suggest 20 ways to profit in vermiculture in addition to selling worms.

- Learn which type of worm is best for commercial breeding and why.
- Find out how to avoid hurting, damaging, or destroying your investment in worms. Proven methods of monitoring the optimum conditions for your worms.
- Causes of success and failure in the worm business.
- Great ways to get free feedstock and bedding for worms.
- Discover the best ways to harvest your crop.
- What you should never do in raising worms.
- Eliminate worry of pests and predators.
- Learn what you can do to prepare for growing worms before your shipment of worms arrives.
- More than worms: Other ways to profit from your business.

...And *much, much* more!

This book was written after researching major landfill diversion sites, touring many different size commercial operations, attendance at composting and vermicomposting conferences and seminars, and research in past and current scientific literature. There is no comparable up-to-date book available in print. It was written with the new grower in mind, but has valuable information for established commercial operations.

Peter Bogdanov is Director of **VermiCo** in Merlin, Oregon. He is a WORC Certified Compost Facility Operator. He has spoken at various conferences, including the International Worm Growers Association, Association of Oregon Recyclers, and at the BioCycle West Coast Conference in San Diego. He is also publisher of the bi-monthly newsletter, ***Casting Call***, which has a focus upon vermiculture, soil fertility, composting, and matters related to organic waste, and which was recently mentioned in an article on vermiculture appearing in *US News & World Report* (Sept. 22, 1997). Most recently, the popular *New Horizons in Vermicomposting* Workshop and Tour featured him as conference organizer and speaker. Bogdanov has contributed articles to various publications, including *Remineralize the Earth* and *Worm Digest*. He recently submitted a chapter entitled, "Vermicomposting in North America," for an upcoming anthology, *Manual on Vermicomposting*, to be edited by Dr. Edwards and released in early 1999.

You can read a review of this book at amazon.com.

Satisfaction Guaranteed! If you re not happy, send it back for a full refund! If you buy only one book on vermiculture this should be it. Discounts available for multiple copies. 1-2 copies $25 ea. 3-5 copies $20 ea., 6-9 copies $18 ea., $10 or more copies $15 ea. Shipping $3 for the first 2 books and $1 for each book thereafter.

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Earthworms for Ecology and Profit, Vol. 1 Scientific Earthworm Farming by Ronald E. Gaddie

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Worms Eat My Garbage by Mary Appelhof

Newly revised and updated, this new edition gives even more information on how to set up and maintain a worm composting system than the popular first edition which sold over 100,000 copies. This book is useful for the home vermicomposter. It tells how to construct a simple worm bin, and what kinds of foods you can feed your worms. Harvesting worms and castings, making potting soil from the vermicompost, and growing healthy plants from recycled food wastes are all covered here.

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Worms Eat Our Garbage by Mary Appelhof, Mary Frances Fenton, & Barbara Loss Harris

Classroom Activities For a Better Environment. A workbook for teachers centered around a classroom worm bin. This curriculum uses over 150 worm-related activities to develop problem-solving and critical-thinking skills in children grades 4-8. Integrates science, math, language arts, biology, solid waste issues, ecology and the environment in ways that draw children into the learning process. See our package deal #303 for discounted package offer.

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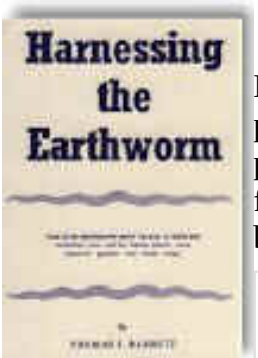
Highly recommended reading. This is a rare and classic book written by Darwin just before he died.

#105	Darwin on Earthworms	$10	Add to Your SHOPPING CART

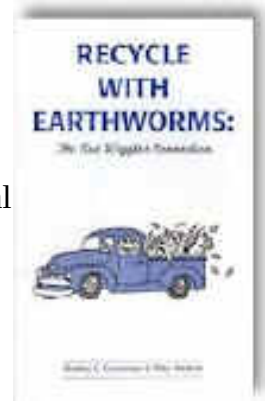


Harnessing the Earthworm by Thomas Barrett

Dr. Barrett describes his book as "A practical inquiry into soil building, soil conditions, and plant nutrition through the action of earthworms, with instruction for the intensive propagation and use of domesticated earthworms in biological soil building." It has facts, figures and illustrations showing how earthworms can be applied to condition your soil for better plants, more beautiful gardens and richer crops.

#106	Harnessing the Earthworm	$10	Add to Your SHOPPING CART

Recycle with Earthworms: The Red Wiggler Connection by Shelley Grossman & Toby Weitzel



This book by two Master Composters with 25 years combined experience is a wealth of knowledge for environment-conscious organic gardeners, hobbyists, and commercial worm farmers. Whether you are a novice or an expert you will appreciate the precise, clear, personal instruction. It includes lots of illustrations and an important trouble-shooting chapter too.

#107	**Recycle with Earthworms**	**$10**	Add to Your SHOPPING CART

OSCR Construction Manual by Dan Holcombe & John Longfellow

This blueprint for a successful vermiculture compost system is modeled on the famous continuous flow, Oregon Soil Corp. Reactor. It includes construction drawings, operators guide, operation plan, parts list, and site license. Build an OSCR from plywood and screws. Add insulation and soil cable heating system to keep the bin at a constant 72° F. Dimensions of the bin are 36" wide x 48" long x 36" high. Make out of new or used materials. Plans include directions to make harvesting screen and audit box. Many diagrams, charts and graphs. Add feedstock to the top of the system and harvest castings and worm tea from harvest chamber below. Use of these bins allows you to keep worms at their happiest in the coldest conditions. (**VermiCo** uses these as incubation bins throughout the winter.) Students at UC Berkeley constructed dozens of these.

#108	**OSCR Construction Manual**	**$50**	Add to Your SHOPPING CART

Earthworm Selling and Shipping Guide by Charlie Morgan

Tells how to sell at home or nationwide at a profit, how to write a classified ad that brings inquiries, and how to write a good sales letter. It explains postal regulations, packages and packaging materials and where to get them. An excellent reference that every worm grower should have.

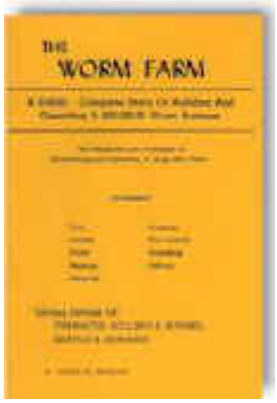
#109	**Earthworm Selling & Shipping Guide**	**$10**	Add to Your SHOPPING CART

Manual of Therapeutic Medications & Pesticides for Worm Growers by Charlie Morgan

This book covers everything from a chemical worm toughener to safe use of pesticides and medications. Tells how to control mites and other insects, harmful bacteria, acidity, plus methods of controlling capsule production and growing larger worms.

#110	**Manual of Therapeutic Medications & Pesticides for Worm Growers**	**$10**	Add to Your SHOPPING CART

The Worm Farm by Charlie Morgan



A diary that explains establishing a successful worm farm and business. Morgan tells the experiences of a worm grower revealing the headaches and triumphs that were part of starting and building a successful business.

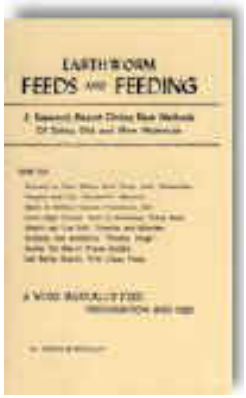
#111	The Worm Farm	$10	Add to Your SHOPPING CART

Profitable Earthworm Farming by Charlie Morgan

A comprehensive treatise by a research biologist, who is also a practical earthworm breeder. Here is a detailed scientific study of earthworm biology, history, types classifications and reproductive processes--PLUS many practical suggestions for beddings, feeding, handling, housing, heating, grading, counting, packaging and selling. Chapters also on Native and African Nightcrawlers, Mealworms, Crickets, Grasshoppers and other live baits.

#112	Profitable Earthworm Farming	$10	Add to Your SHOPPING CART

Earthworm Feeds and Feeding by Charlie Morgan



A research report based on many years work and experience solving worm breeding problems. Tells how to prevent mites, acid beds, protein poisoning. Answers questions about best feeds and the use of antibiotics. Describes methods for making synthetic manure plus many other ideas and methods used by leading worm growers. It is filled with vital information and is a valuable reference for every worm grower.

#113	Earthworm Feeds & Feeding	$10	Add to Your SHOPPING CART

Raising the African Nightcrawler by Charlie Morgan

The only complete book yet written concerning this fascinating and highly profitable BIG worm, to which so many established growers are now turning for extra profits. A thoroughly detailed book of primary importance to anyone who plans to experiment with Africans.

#114	Raising the African Nightcrawler	$10	Add to Your SHOPPING CART

How To Raise, Store & Sell Nightcrawlers by Charlie Morgan

This is about the tough, big northern nightcrawler so popular with fishermen in many areas, the worm that brings a premium price. Morgan tells how to raise the northern nightcrawler

inside and outside. He covers what beddings and feeds to use, how to harvest and store them, tips on selling, packaging and shipping. It is full of useful information every worm grower can use.

#115	How to Raise, Store & Sell Nightcrawlers	$10	Add to Your SHOPPING CART

Dear Charlie compiled by Patrick H. Shields

The world renowned "wormologist" responds to your questions about worm farming in this book. A collection of correspondence between the late Charlie Morgan and worm farmers around the world. They ask a wide variety of questions and Charlie answers them in his inimitable style. His scientific knowledge and ability made him a leading expert and authority in worm farming. This led to an extensive consulting business. The letters are classified by subject matter, including Red Worms, African Nightcrawlers, Northern Nightcrawlers, Pests, Pharmaceuticals, and miscellaneous material. Charlie keys in on the more common problems.

#116	Dear Charlie	$10	Add to Your SHOPPING CART

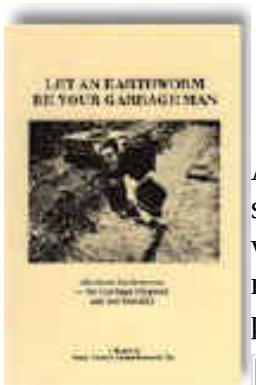
#302 Charlie Morgan Package: All 8 books by this famous author.
Total Package for just $65 includes free shipping
A $112 VALUE if purchased & shipped separately!
SAVE $47!

#302	Charlie Morgan Package	$65	Add to Your SHOPPING CART

With Tails We Win by Mary Crowe and Gladys Bowen

This is a cleverly written and fascinating story of two professional women who operate a practical and profitable earthworm "farm" on a city lot--a project that grew out of a "miracle in a flower pot" and grew and grew and GREW! You'll enjoy this little book a useful breeding guide, seasoned with humor and backed by practical experience.

#117	With Tails We Win	$10	Add to Your SHOPPING CART



Let An Earthworm Be Your Garbage Man

A-Worming We Did Go by Ruth Meyers

An inspiring account of how a handicapped woman starting "on a shoestring" built 1000 worms into one of the best known worms farms. You will enjoy her friendly, humorous style as she instructs how to build bins, mix feeds, tackle enemies of the earthworm and gives valuable tips on packaging, advertising, and working with bait dealers. Photos of operation.

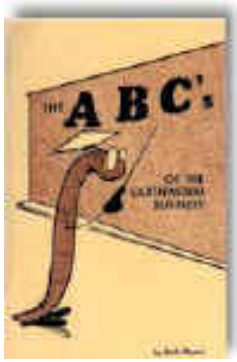
#119	A-Worming We Did Go	$10	Add to Your SHOPPING CART

Larger Red Worms by George H. Holwagger

An interesting report by an earthworm breeder whose eminent success has been largely due to his ability to produce a larger red worm faster, and at amazingly low cost. He passes on to others the story of his revolutionary feeding and fattening methods.

#120	**Larger Red Worms**	**$10**	Add to Your SHOPPING CART

The ABC s of the Earthworm Business by Ruth Myers



The author draws on 10 years experience in building one of California s biggest worm farms to give information the "newcomer" wants to know. Includes such things as selecting breeding stock, getting off to the right start, marketing, selling bait dealers, mail orders and more.

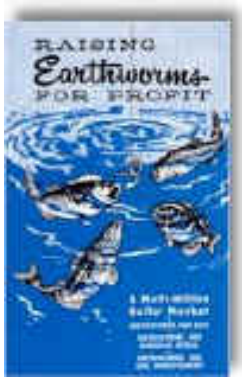
#121	**The ABC's of the Earthworm Business**	**$10**	Add to Your SHOPPING CART

Raising Fishworms with Rabbits by Howard "Lucky" Mays

The author, breeder of champion rabbits, shares his experiences in establishing a profitable business of raising worms under rabbit hutches, an ideal combination.

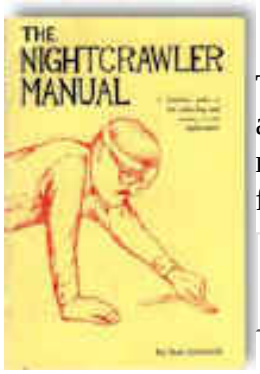
#122	**Raising Fishworms with Rabbits**	**$10**	Add to Your SHOPPING CART

Raising Earthworms for Profit by Earl B. Shields



This comprehensive book is useful to the prospective grower. It has 128 pages of usable information, with 62 photographs, 37 drawings. You'll find many ideas, methods, advertising and sales helps for the beginning or established grower. It also has a complete section on the African Nightcrawler.

#123	**Raising Earthworms for Profit**	**$10**	Add to Your SHOPPING CART

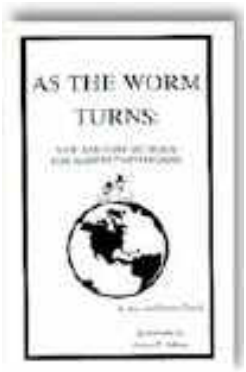


The Nightcrawler Manual by Ray Edwards

This is the complete guide to harvesting and storing native (northern) nightcrawlers. It tells about methods used by experts with photographs and illustrations. It describes equipment needed to get started and techniques used to store bait for six months. Ideal for the avid fisherman or bait dealer.

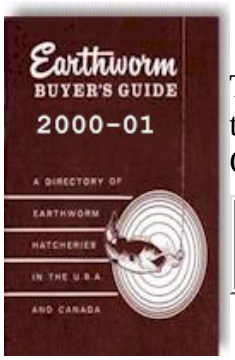
#124	**The Nightcrawler Manual**	**$10**	Add to Your SHOPPING CART

As The Worm Turns: New and Easy Methods for Raising Earthworms by Roy and Diane Fewell



A simply written treatment of the subject, with index and list of worm resources at the end.

#126	**As the Worm Turns**	**$10**	Add to Your SHOPPING CART

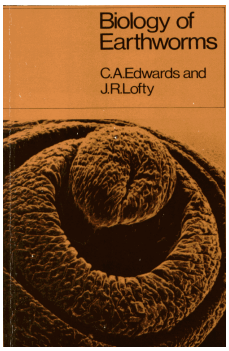


Earthworm Buyers Guide & Directory 2002-2003

This edition marks nearly 50 years of publication, a period during which it has grown in value to the earthworm industry. Its 80 pages list leading earthworm growers in the United States and Canada with the names of owners, types of worms sold, and related items and information.

#127	**Earthworm Buyers Guide**	**$10**	Add to Your SHOPPING CART

Biology of Earthworms by C.A. Edwards and J.R. Lofty (1972)



In this classic, first edition of Dr. Clive Edwards' textbook, the fundamental aspects of the biology and habits of earthworms are presented. The authors state that "no previous book has attempted to review all aspects of the biology, morphology, physiology, taxonomy, and ecology of earthworms, and we hope that the present volume may help to fill this need." Filled with pictures, charts, graphs, tables, and diagrams, this reasonably priced scientific text has value for today's student of earthworms and their role in soil fertility.

#128	**Biology of Earthworms**	**$20**	Add to Your SHOPPING CART

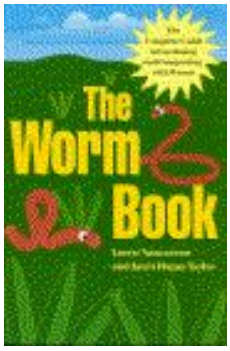
Worm Café: Mid-Scale Vermicomposting of Lunchroom Wastes

by Binet Payne

This 1999 manual has been written especially for schools, small businesses and community groups. In this book, Payne has detailed how to incorporate your own mid-scale worm composting program through project-based learning. The *Worm Café* is richly illustrated and offers a wealth of useful information. This is **must** reading for teachers interested in starting their own classroom or school-wide vermicomposting program! Read a review of this exciting new book from the February, 1999 issue of *Casting Call*.

#130	Worm Café	$30	Add to Your SHOPPING CART

The Worm Book by Loren Nancarrow & Janet Hogan Taylor



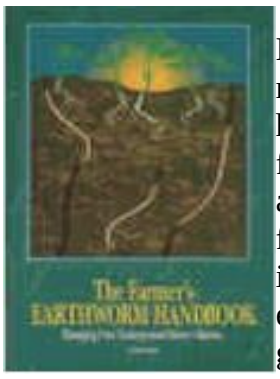
This book was written as a complete guide to Gardening and Composting with Worms. It tells you how to build a worm composting bin including diagrams for several different bins, from basic to deluxe. It educates on how worm composting works, and why it is such a good idea. It explains the use of worms, castings, and vermicompost in the garden and even gives recipes on how to cook with worms!

Contents: Chapter Titles

1. Why Do We Need Worms?
2. What is a Worm? Basic Worm Biology
3. How Do You Get Started?
4. Maintaining A Worm Bin
5. Problems in the Worm Bin
6. Other Animals Found in a Worm Bin
7. Using Worms, Castings, and Vermicompost in the Garden
8. Earthworms in Agriculture
9. Commercial Worm Growing: Can You Do It?
10. The Whole Worm and Nothing but the Worm
11. Cooking with Earthworms

#131	The Worm Book	$12	Add to Your SHOPPING CART

The Farmer's Earthworm Handbook: Managing Your Underground Money-Makers by David Ernst



Everything you always wanted to know about managing earthworms--those underground money-makers--but didn't know who to ask, is found in the 112 pages of this valuable handbook. Dealing with all aspects of managing earthworms more profitably in your farming operation, hundreds of rigorous scientific research ideas from leading scientists around the world are balanced with many practical in-the-field cropping ideas from farmers. These are farmers who fully believe in what earthworms can mean in the way of increased yields, reduced costs and higher profits in their fields. You'll learn how earthworms allow more air and water to penetrate the soil, improve fertility, help plant roots grow deeper and increase crop productivity.

Some 19 chapters delve into all aspects of on-farm earthworm management...from seeding fields with nightcrawlers, increasing worm populations as well as earthworm friendly fertilization and pesticide application,

manure management, sustainable agriculture, the worm's impact on tillage systems, cover crops, crop rotations and the dozen major benefits of increasing worm numbers in your fields. There's an in-depth chapter on understanding the biology of worms and properly identifying the most common earthworms found in North American fields.

#132	**The Farmer's Earthworm Handbook**	**$16**	Add to Your SHOPPING CART

Best Management Practices in Vermicomposting Manual

Since we began the two-day Seminar in September 1999, we've had many requests for the material in the *Best Management Practices in Vermicomposting* Manual. Several have asked if the course manual is for sale. Until now, we've only made the manual available at the Seminar, largely to encourage people to attend the live performance. However, we realize that many people, for many reasons, simply cannot attend, but would appreciate having access to the material found in the manual.

Our first manual contained about 250 pages and our attendees spoke very highly of it. Today's current edition contains over 420 pages divided into 13 tabbed sections. In the actual seminar, power point presentations, slides and videos are used in the first 4 or five sections only. Because of the great number of guest speakers used, we have never covered all the material contained in the manual during the live presentations. There simply has not been enough time to cover all the material over the two-day event.

Chapters in the Best Management Practices in Vermicomposting Manual

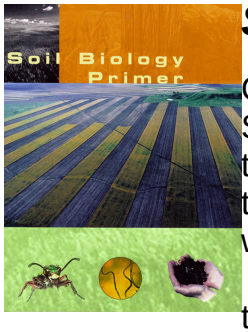
- 1. Introduction: Waste Management Issues
- 2. Composting: The Process
- 3. Compost: The Product
- 4. Biology & Ecology of Earthworms
- 5. Vermicomposting: Process & Product
- 6. Marketing
- 7. Financing
- 8. Site Design
- 9. Operations
- 10. Business Plan
- 11. Regulations
- 12. Resources
- 13. Glossary of Terms

If you are unable to attend one of our Seminars but would like to purchase the manual, we are making it available for the same cost as advance registration fees for the seminar--just $249 with free shipping in the US and $35 shipping outside US. The purchase of the manual also includes a coupon for a special half-price offer (for one person), for a future seminar registration. Please note that all sales are final and no refunds will be given.

Best Management Practices in Vermicomposting Manual with 1/2 off coupon for a future Seminar

#1003……$249

#1003	***Best Management Practice in Vermicomposting* Manual with coupon**	**$249 with free shipping**	Add to Your SHOPPING CART



Soil Biology Primer

Get the Dirt on Soil Biology

Soil filters our water and contributes to plant growth. But it's not the soil that is doing these important jobs it's the microorganisms living within the soil. In just a spoonful, there are more microorganisms than the number of people on earth. How does this work?

The *Soil Biology Primer*, a 4-color, 48-page publication, introduces the reader to the living component of soil and how that component contributes to agricultural productivity and to air and water quality. It's an excellent resource for gardeners, farmers, ranchers, ag professionals, resource specialists, conservationists, soil scientists, students, and educators. The *Primer* includes information on the soil food web—the community of organisms living in soil—and how the web relates to soil health. Chapter topics include bacteria, fungi, protozoa, nematodes, arthropods, and earthworms.

#134	**Soil Biology Primer**	**$20**	Add to Your SHOPPING CART

Compost Tea Manual 3rd ed. by Dr. Elaine Ingham

Dr. Ingham's comprehensive manual on making, applying, and assessing compost tea is now available in its 3rd edition. A must for any user of compost tea from backyard gardener to range manager.

Included in this Print Publication:

- What is Compost Tea?
- When and Why to Use Compost Tea
- Factors Affecting Compost Tea Quality
- Beneficial Organisms in Tea
- Compost Tea Production Methods
- Commercial Brewers
- Application Amounts and Methods
- Making Compost Tea Appropriate to the Plant
- The Kind of Compost Tea Needed for Different Plants, Soil Types
- The Recipes
- Troubleshooting
- Literature Review of Compost Tea Use
- Field Experiences
- Feedback Request
- Glossary of Terms
- Literature Cited for further reference

#135	**Compost Tea Brewing Manual**	**$30**	Add to Your SHOPPING CART

Casting Call

VermiCo's bi-monthly newsletter, keeps readers up-to-date with the latest developments in vermiculture. Every 60 days we bring you the biggest stories, events, book reviews, interviews with industry leaders, and news items to keep you informed. Our primary focus in upon vermiculture, composting, soil fertility and related issues of organic waste. Satisfaction guaranteed or money back. 6 issues per year. Subscription rate outside of the United States is $24 per year.

#700	***Casting Call***	**$18**	

#700-a	***Casting Call-outside the United States***	**$24**	

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Get the first 30 back issues of *Casting Call*, Volume I and Volume II & Volume III, Volume IV and Volume V in a bound edition for just $30.

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Preservation
Report an Environmental Problem
State Parks
Water Information

The Page Cannot Be Found

Due to restructuring of our Web site, the page you are looking for may have been removed, had it's name changed or may be temporarily unavailable.

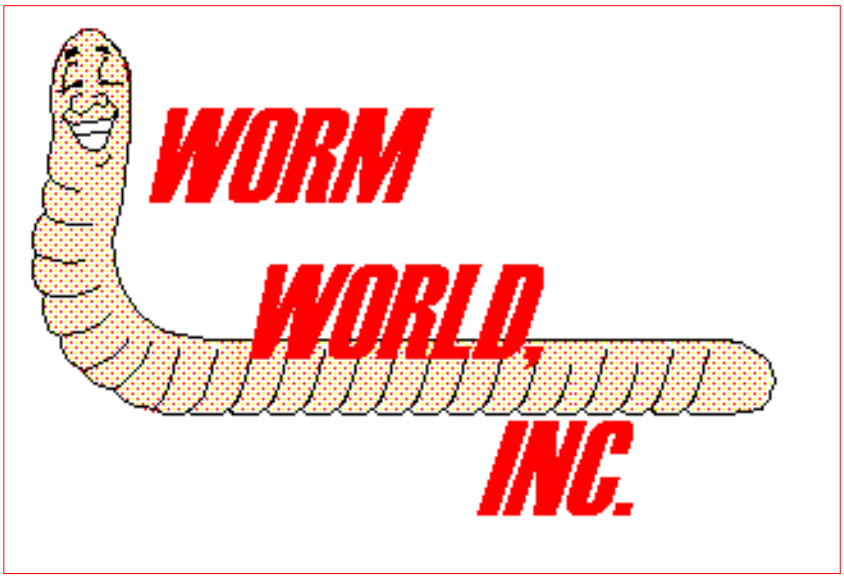
The Water Pollution Control Program and the Public Drinking Water Program have been incorporated into a single Water Protection Program. Even though our name has changed, our mission to protect the environment will always be our top priority. We believe our reorganization will make the department more user-friendly to the general public and regulated entities across the state. So change your bookmark and visit our new home page to learn more about our efforts to improve and protect water quality for all of our residents.

Please view our Site Map to find a listing of the divisions, programs, offices and special topics we have to offer.

If you are unable to find what you want, simply use the e-mail link below to send us an e-mail and someone will contact you soon.

Department of Natural Resources
P. O. Box 176, Jefferson City, MO 65102
1-800-361-4827 / (573) 751-3443
E-mail: oac@dnr.mo.gov
Revised on Wednesday July 21 2004

Free Speech Online
Blue Ribbon Campaign



is

Proud to Present...

"THE BURROW"

THE WORM GIN--Putting The Profit In Vermicompo$ting

For information on the revolutionary new 'Worm Gin', the automated large-scale Vermicomposting machine Click Here!! Now with Pictures !!

Vermicomposting References For reprints of articles on Vermicomposting, Click Here !!

For the most Advanced Worm Harvesters you have ever seen, Click Here!!

For Rotary Composters and Compost Screeners

Click Here!!

The rest of this page,"THE BURROW", was written by my Canadian friend, Brian Paley a few years ago. He has since moved on with his life, and so this page has not been updated. For those of you looking to learn more about worms, it still makes for fascinating reading.

The Burrow Presents How To Raise 100 pounds of Worms Part 1..2..3..4..5..6..7	An Explanation of an Idea!

Fact Sheet #1	Bedding and Bedding Materials	Compost Critters--Pests and Pest Control
Light and Dark in Regard to Worms	Business Claims To Consider	Method of Reproduction
Willy the Worm's Wonderful Words of Wisdom	Science Fair Bins	Questionable Bedding?

The Smallest Horticulturist	Important, Strange, and Funny

Plans for a Worm Bin

Environmental Requirements for Redworms	Sorting and Sorters

The Mandatory Link Page	A Vermicomposting Primer

The Effect of Earthworms on Soil Improvement	Earthworms and Hydroponics

Earthworms in General	Worm Composting
Composting Information Via The Compost Guide	The Tree of Life
Worm Composting With City Farmer	Worms in Grade One
The Gardeners Advantage	
KAZARIE Worm Farm Since we don't sell worms, try here.	The Worm Digest

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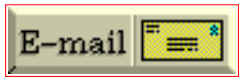
[Internet Search Engines]

We do not sell worms

For Further Information

Brian Paley is currently out of town, but we will hold his mail for him.

harry@jetcompost.com



If you need a quick answer to a worm question, try the Worm Digest's Worm Forum.

If you have a question about large-scale vermicomposting, or about the Worm Gin, ask Worm World Inc. at harry@jetcompost.com

To the Links Top of Page

Words to search by: worm, worms, vermicomposting, composting, earthworms, manure, manure worms, save the planet, help the world, brian paley, burton windle, harry windle, burrow, worm gin, The Burrow, Worm World Inc., Worm World, recycle, organic waste, food scraps,

A Bibliography of Worm-Related Books

Bedding

WORM BEDDING

(Other Than Manure)

(which will require an article of its own.)

Table of Contents

Introduction
Peat Moss
Bog Soil
Newsprint
Machine-Shredded Paper
Cardboard

An Introduction

Of all the ingredients and materials necessary for the indoor culturing of red worms, bedding, which is one of the most important, is also quite possibly the most often neglected. The purpose of good bedding material is apparently one of the least understood aspects of a vermicomposting system, and improper maintenance of this bedding is frequently one of the main reasons for the failures encountered by those who are new to the process. At various times, I have seen worms which were housed in bedding that was too dry, too wet, too dense, and even too coarse. I have also witnessed worms living in their food--having no bedding at all--and while there are situations where this might be the proper practice, indoor culturing is not usually one of them.

Before we discuss the various materials which are suitable for this purpose, and the advantages or disadvantages inherent to each, let's take a moment to decide what we are trying to accomplish by providing the worms with bedding in the first place. We can do this by looking at what the worms need in order to lead healthy and productive lives, and then deciding which of these needs are dealt with most efficiently by the bedding.

A Worm Needs....

- Food to eat.
- Environmental conditions free from rapid fluctuation.
- Shelter from light sources.
- Access to potential mates. And...
- Delicate handling.

Now if we only had the worms to consider, that would just about do it. However, when we talk about cultured worms, we must also consider the needs of those who are doing the culturing, namely you and yours truly.

A Vermiculturist Needs....

- Healthy, productive worms.
- Freedom from foul-smelling bins.
- Freedom from intrusive pests. And...
- Easy access to required materials.

(A winning ticket in the local lottery is probably out of the question?!)

With that in mind, we can now set down at least a couple of basic qualifications for what makes a good worm bedding. Though these are not the only considerations by any means, these points will go a long way to setting us on the right path.

Bedding Material Should....

- Retain moisture in a form that is accessible to worms.
- Stay loose and allow for air passage between the individual particles.
- Allow for drainage of excess moisture.
- Not be coarse enough to damage a worm's delicate skin.
- Not be a food source that is high in protein.
- Be aged past the heating stage. And....
- Be free of topsoil. (Red worms are compost or manure worms as opposed to earthworms.)

So, with all of these points in mind, let's get down to the job of looking at the available options, and the various pros and cons associated with each. Just before we do, however, I should point out that I am not trying to nudge anyone in one specific direction or another. All I am really interested in is giving everyone enough information so that they can decide on whichever bedding will best suit their individual circumstances, and a pointer or two on how best to use whichever one they finally decide upon. Each of the following materials are suitable as worm bedding, but some will simply be ***more*** suitable than others for

your particular needs. So if that is clear to everyone.....we may proceed.

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Peat Moss

With the exception of manure (a topic we will deal with in a later article), peat moss is probably the most widely-used of all the worm beddings. A few years ago, we could even have defined this material more specifically as "Canadian" peat moss, or sphagnum moss. The reasons for that particular preference had to do with the fact that the Canadian peat moss was a sterile medium, whereas the American peat moss was more likely to contain various impurities which might have proved harmful to the worms. Though many breeders still ship worms in Canadian sphagnum, often at the specific request of the buyer, if reasonable care is exercised, just about any peat moss may now be used.

Since I can already hear the multiple screams heading my way, let me explain what I mean by ***reasonable*** care. First of all, any suspicious moss should be thoroughly "leached" before it is used as worm bedding. This is a simple matter accomplished by soaking the material for a few hours (or overnight) in clean water, and then squeezing out the excess moisture. If the water you squeeze out is dirty, the process should be repeated until the resulting flow is as clean as when it was first added. At that point, resist the temptation to add your entire worm population to the moss until you have first allowed a brave handful of worms to try out the new accomodations for at least one entire night. If they survive, chances are the others will also. Of course, if you are fortunate enough to have access to some of the true Canadian sphagnum, you can probably skip the first step altogether, and proceed directly to the test with the partial population. I do, however, strongly suggest that you never skip the second test. You may get away with it 99 out of 100 times, but just one bad batch of moss and....well, you get my point.

Like most other bedding materials, peat moss has both advantages and disadvantages. The reason for its popularity, however, is that the advantages

pretty much outweigh the negative aspects, and those things considered to be disadvantages can often be used in a positive manner. If we understand each of these characteristics, and make the best use of them, it becomes easy to see why so many worm breeders favor this material.

Among the **advantages** of peat moss can be found the following items:

1. **Moisture Retention.**
   Because it retains moisture so well, peat moss can lessen the amount of daily attention required by the worm bed (a major plus in multiple-bed situations.) And less watering means you will have that much more time to teach the worms to dance, recite poetry, or run for political office. In all fairness, I have to admit I have heard at least one individual express concern that while peat moss does indeed retain large amounts of moisture, the water is trapped inside the fibres, where the worms cannot make use of it. I also have to admit that I find that a little hard to believe, since the worms ingest the entire fibre, water and all. If any worm has ever died of thirst while living inside moistened peat moss, I, for one, have never heard about it.

2. **Cleanliness.**
   This is one of those characteristics you can only appreciate if you have had prior experiences with bedding materials that are not so easily handled, such as manure or leaf mold. Properly moistened moss is a pleasure to handle, and if you should drop a little here or there, just let it dry, and vacuum or sweep it up.

3. **It Has No Inherent Odor.**
   Though worms tend to deodorize most materials simply by their existance within the medium, there is often a short period of time where some beddings might be just a little offensive to those of us with delicate sensibilities. No such problem with peat moss, a definite plus in my books.

4. **Availability and Consistancy**
   If you happen to live in a rural area, the availability of material for worm bedding should never be a problem. Urban living, however, can often present certain difficulties. Aside from having to gather materials, storing those which you manage to accumulate can present additional problems.

For those with very limited storage space, or lacking suitable amounts of the time or inclination required to gather materials, peat moss offers easy access, usually at a reasonable cost. Any decent garden-supply shop will have this material on hand, and a medium-sized bag can usually be purchased for just a few dollars. For the average indoor system, a bag of moss will usually last several months, and if the same brand is constantly used, the worms will not be subjected to the rapid changes of condition that can so often raise their mortality rate.

5. **Diversity**

   Last but not least among the advantages of using peat moss as a bedding material, we should make mention of the wonderful diversity of this substance. Not only can peat moss be used alone, but it can also be used to enhance just about any other bedding material, and even as a method of rectifying certain problems encountered with other products, and also some environmental problems. For instance, if a certain bedding material drys too rapidly, adding a 30-50% mixture of moss will help to retain the necessary moisture level. In beddings that are too dense, peat moss will add a little porosity, and in materials that are too far on the alkaline side of the pH scale, the acidic nature of peat moss can serve to bring things into a better balance. When used as a shipping medium, peat moss will retain enough moisture to cool the worms, without requiring so much water that it will easily freeze solid. The fact that this material is lighter than most will also save some of the shipping costs, and because of its sterile nature, you may encounter less hassle from Customs when shipping internationally. All in all, peat moss has a lot going for it, and eventually, just about every worm breeder or vermculturist will come to consider it an indespensible part of their operation.

Among the **disadvantages** of peat moss can be found the following items:

1. **The Cost.**

   Now I know I already said that peat moss was inexpensive, and it is (as long as we are talking about a regular-sized indoor operation.) However, many other bedding materials are free, so we have to be fair and call any price-tag at all a disadvantage. In the situation of a larger set-up, the cost can rapidly add up, and for commercial applications, the expense would be simply ridiculous. What this means is that peat moss is a great choice for

an indoor bedding for a regular-sized set-up, but can only serve very specific needs for anything much larger than a one or two-bed system.

2. Its Acidic Nature (pH)

By its very nature, peat moss is an acidic substance. Since the worms prefer a pH that is close to neutral (or **very slightly** acidic), this can present a problem if certain precautions are not taken. First of all, worms that were previously housed in bedding materials that were neutral or slightly alkaline, should never be transfered directly into straight peat moss. Though I have raised several batches of worms in sphagnum (moss), they were either hatched initially in that substance, or gradually acclimated to the new conditions. To acclimatize worms to new bedding, I simply transfer an amount of the old material, worms and all, to one side of the new bed, opposite to the fresh bedding. The worms will then move into their new environment at their own pace, and the number of casualties is considerably reduced. (This procedure should be used whenever you place newly-received worms into a bed that contains material other than that which they were shipped in.) On the plus side of this matter, the acidic nature of peat moss can be used to balance other beddings (or soils) that have become too alkaline for whatever reason, something that gardeners everywhere have known for years.

3. A Lack of Nutritional Value

Since peat moss is made up of very old plant matter that has been sitting in, or under, a bog for many, many years, whatever nutrients it may have contained in a previous lifetime (spooky, huh?) have all been thoroughly leached out, which means that not even a worm can live on a steady diet of this material for any length of time. As far as that being a disadvantage or not, I guess it's merely a matter of personal opinion. If you are more interested in getting rid of food scraps (or some other feed source), rather than peat moss, you might consider this to be a benefit, since the worms will rely on the feed for nutritional value, and the peat moss will add body as it gets blended into the final mixture. This tendency to add to the structure of the finished compost is one of peat moss's best selling points, so maybe this item should have been listed under advantages after all. (Too late.)

All in all, a truly remarkable substance, and as we've already stated, a bedding

material widely-used by vermiculurists around the world.

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Urban Agriculture Notes

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Worms: The New "Bug" For The New Millenium

by Spring Gillard
gardnhrt@interchange.ubc.ca

Worms make great pets. They're quiet. And all they do is eat and reproduce all day long. But perhaps most importantly, in the face of the "Y2K" problem, they eat our garbage.

"In the GVRD, we produce over two million tonnes of garbage annually, that's enough to fill BC Place Stadium twice. Just by recycling, you can cut your garbage down by a third. By adding composting into the mix, you can cut it down by another third." So begins a class in vermicomposting (composting with worms) at City Farmer's Compost Demonstration Garden in Vancouver. Instructor, Ellen York is in full costume. Her long black T-shirt reads: Black Gold and the Power of One; her worm earrings undulate creepily from her lobes as she belts out the "Compost Rap" to surprised participants.

Apartment dwellers in Vancouver have been taking advantage of a subsidized city program for five years now. After a one hour mandatory "wormshop", graduates take home a bin, worms and all the vermi-nalia they need to start a balcony worm farm. All this for $25. With worms selling for about $40 a pound, it's a steal of a deal. And the end product is a dark, nutrient rich fertilizer for your flowers and garden. Gardeners in the know have been scooping up this expensive "black gold" (a fancy name for worm poo) off nursery shelves for years - now there's a cheap and easy way to grow your own.

The Composting Council of Canada estimates that Canadians composted over 1,650,000 tonnes of organic materials in 1998 - up 23% since 1996. Diversion of organic waste from worm composting makes up a small percentage of that figure - but municipal solid waste departments, keen on getting their 3R's message out, are hopping on the worm wagon; vermicomposting provides yet another opportunity to worm their way into public consciousness.

"Worms capture people's attention", says Al Lynch, head of North Shore Recycling.

"One article on worms in the local paper generates more calls to us than a whole series on backyard composting. Worm composting may not even be appropriate for the caller, but it gives us a chance to educate them and get them set up with a backyard bin or redirect them to a greenwaste drop off site." Worms are a great hook for the media too. Red wigglers have been featured in national daily newspapers, in magazines like Time and Canadian Living and on national television shows like David Tarrant's Canadian Gardener. Trade papers like Worm Digest and Casting Call serve up monthly news from around the worm world including scathing reports on get rich quick scams and reviews of reputable commercial vermiculture books. It would appear that wormania is sweeping the nation.

The worm movement began in the 70's with a woman named Mary Appelhof, a biologist from Kalamazoo, Michigan. She wrote the industry bible, **Worms Eat My Garbage** in 1982. Now a highly sought after speaker at science and environmental conferences, Mary has spread the worm word around the world, touring Australia, the Philippines, England, France, Ireland and recently Russia.

"Some people get very creative when it comes to their worms," says York. We've had people make worm bin coffee tables and you can only imagine the conversations when they have guests over for tea." Some wormshop graduates really catch the worm bug; one such "wormie" named her pets the Supremes and swears they sing Motown when she leaves her apartment.

In addition to municipal programs for apartments, many schools across the country are putting worm bins in classrooms. In Ontario, an estimated 20,000 worm bins have been distributed to apartment dwellers through provincial/municipal programs. A curriculum supplement developed in Alberta uses worms as "teachers" in the classroom. Even office buildings are getting into the act. At the British Columbia Institute of Technology in Burnaby, scraps from the cafeteria are composted in large wooden worm bins in the parking lot. And in Nova Scotia, a large scale worm composting system has been set up on the Greenwood Airforce base, complete with air temperature control and hydraulic harvesting capabilities.

So could you just go and dig up a bunch of these worms from your garden instead of forking out the forty bucks? No. Wrong kind of worm. While your garden variety worm is a burrower, travelling deep into the earth, aerating your soil and subsisting on dirt, the compost worm or red wiggler is a surface dweller, at home in leaf piles, manure piles and backyard compost bins. If you'd rather not pick through a pile of horse dung, City Farmer maintains a list of worm farmers across North America on their website ; you can mail order from most of them.

Worms are not only found in apartment blocks and school rooms, they're also at work in cold climate dwellings. Once the backyard compost bin freezes up, many avid composters move indoors and begin feeding their food waste to a wormbin under their kitchen sink, in the basement or a heated garage. In Michigan where temperatures can drop to -10 C, Appelhof surrounds her outdoor worm bench with bales of straw and inserts a birdbath water heater to keep her worms toasty.

Seven-watt night-lights will also boost temperatures, although the light may inhibit worm activity. Even on the balmy, wet coast, worm bins should be insulated for the winter - generally a well-padded cardboard box covered in plastic is sufficient.

Keeping a worm bin inside the house can have its problems. The optimum temperature for happy worms is 15-25 degrees C; sadly, flies also thrive under those conditions. Fly eggs come in on fruits and vegetables, so wash them well before you peel - especially the bananas, melons and oranges. A plastic garbage bag laid on the bedding helps to smother fly eggs on the surface as well.

And just in case you were thinking of keeping your worms atop your stereo speakers or next to the washer/dryer, think again. Worms are vibration sensitive and you could set off something-called worm crawl. While it's unlikely they'll be all over your kitchen floor in the morning, they will amass on the inside of the lid. This is wormspeak for "we are very unhappy".

Another potential problem indoors is leachate spillage. Leachate is a lovely by-product of worm composting. It's a mixture of the liquid from the food waste and the worm castings (again, worm poo!). It makes a highly concentrated liquid fertilizer - but you need to dilute it at least ten to one before you water your plants with it. If you spill this precious stuff on your carpet, you will never get it out, so handle with care. York uses a turkey baster to suck up the "gravy" every couple of months, and then stores it in a lidded jar.

It was just such a list of potential problems that had Victoria's Apartment Owners and Property Manager's Association squirming back in '93. They raised their concerns with the Capital Regional District, and the pilot worm distribution program was canned. So let's say garbage pick-up does grind to a halt as of January 1, 2000, just how much of your "garbage" will worms eat. Well, in a 53 litre bin, you can expect to compost about 4 litres a week (think ice cream pail). That may not be enough, especially if you're a vegetarian. Many people start with one bin, then after their first harvest (separating the worms from their castings and remaking the bin), they divide their worms and start a second bin.

And what do worms like to eat? Uncooked fruit and vegetable waste along with coffee grounds and filters, tea bags (remove the little staple, it's hard on their delicate digestion), and egg shells. Grains and cooked food aren't recommended, as they really smell when they break down and can attract rodents or really piss off your neighbours. Meat, fish, dairy, oils and pickled things are all no no's too.

So back to why worms work for Y2K. The approaching millennium with all its potential for havoc gives us one more reason to manage our own waste. The less dependent we are on outside systems (like garbage pick-up for example), the less Y2K (or ice storms, floods, earthquakes) can disrupt our lives.

"In this day and age, it's easy to get overwhelmed. We say oh, there's so much wrong with the world, what can one person do?" says York. "At City Farmer we like to say that if everyone looked after their own backyard, the world would be a very different

place. I think worms are a wonderful symbol of the power of one. They eat their own body weight in food everyday and that translates into a lot less garbage going into the landfill."

All this just to say: worms are Y2K compliant. They work all year, any year. If we look at Y2K as an opportunity to become more self-sufficient, then the millennium bug is reduced to a beneficial pest.

To register for a City of Vancouver wormshop, call the **GVRD Compost Hotline at 736-2250** (Vancouver residents only).

How To Set Up A Worm Bin

So how do you start a worm bin if there are no nice neat kits available in your city? A visit to this City Farmer page will tell you exactly how to set up a bin and where to get the worms, but here are the basics. Start with a plastic storage container, approximately 53 litres in size. Drill some holes in the sides at the top, and a few in the bottom for drainage. Fill the bin with stripped up, dampened newspaper and dry, fall leaves or straw, sprinkle in a couple handfuls of dirt, bury approximately four litres of food waste in a corner and you're ready for the worms - a half pound will do. You'll also want to elevate the bin and put a drip tray underneath to catch the leachate. Call the Compost Hotline (604-736-2250) for a copy of the GVRD brochure: "Guide to Worm Composting".

Worm Resources

If you want to dig deeper into the world of worms, check out some of the resources listed here.

City Farmer Web Site (www.cityfarmer.org): This site links to many other worm sites.

Composting Council of Canada: (www.compost.org) or call (416) 535-0240; order the Alberta Curriculum Guide, Composting Goes to School here.

Compost Module: a curriculum supplement for K-7 including video, activity booklet and poster. To order call Force Four Productions 604- 669-4424.

Mary Appelhof (www.wormwoman.com): For information on Mary's books, curriculum guides, videos and worm kits, call (616) 327-0108.

Worm Digest: a monthly trade newspaper (www.wormdigest.org) or call for subscription info (541-485-0456). Vermico: publishes a book on commercial vermiculture and a monthly newsletter called Casting Call: (vermico@cdsnet.net) or

call (541) 476-9626.

New Feature! Search Our Site NEW

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Urban Agriculture Notes

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Wormshop: How to Harvest Your Bin

A QuickTime Movie

Download of the QuickTime Movie (2MB) will take some time depending on your connection speed.

A QuickTime Movie
Created by John Corry
John Corry
bnewmedia 1999

You'll need QuickTime from Apple to play the movie, which you can download from here (keep in mind that it is 6.8MB in size). The installation is simple, and will install a quicktime plugin into your favorite web browsing application.

This was our first attempt at movie-making for the Internet, prepared over a year ago. See our latest effort (at the bottom of this page) where we used a digital camcorder and Firewire.

This short movie clip (about one minute in length) is taken from one of City Farmer's wormshops for adults which takes place at the Vancouver Compost Demonstration Garden. Spring Gillard, who teaches these classes, is also the Compost Hotline Operator.

The movie clip was digitized from a VHS tape with a time code burnt into the picture. Using Adobe Premiere 5.0 and a Miro DC 30 card, a 640x480 pixel, 44.1 kHz, 16 bit mono audio clip about one minute long was captured (using the Miro MJPEG

format). The total file size was about 50 MB. The image was then compressed using Terran Movie Cleaner Pro 3 and the Sorenson variable bit rate codec. The image was cropped within Terran Movie Cleaner Pro to remove the time code burn and save some pixels. The sound was compressed to 16 bit, 22kHz. The resulting file size is about 2 MB, with a data rate of about 32 kBs.

Spring Planting, 2000, QuickTime 4 Movie of our Compost Garden

This clip from the garden shows our "chien bizzare", catches gardener Sharon Slack planting onions, Chinese cabbage and leeks, and scaring Starlings away.

Made with a digital camcorder, a Mac computer and a Firewire cable, these clips are best viewed using a fast Internet connection, e.g. Cable or ADSL. Those with lesser speeds can let the file download slowly before playing it. Size 10.6 MB, length 1.5 minutes. You must have QuickTime 4 installed as well. Posted May 5, 2000

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Urban Agriculture Notes

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Black Gold and the Power of One

500 Worm Bins Distributed by City of Vancouver

"You might be wondering about the T-shirts we're wearing", says Spring Gillard, one of the wormshop instructors at City Farmer's Compost Demonstration Garden. **Black Gold and the Power of One is written** - in gold paint of course - across her black oversize T-shirt.

"Well, we like to think that if everyone had a worm bin on their balcony or a compost bin in their backyard - that is if everyone looked after their own backyard - the world would be a different place.

City Farmer is distributing 500 worm bins for the City of Vancouver. These 'black gold machines' and their inhabitants - 500 red wiggler worms - will chow down on your food waste and turn out a beautiful rich organic fertilizer for your plants in about two to three months. "Black Gold is just a fancy name for worm poop", says Hilary Pada, another member of the Worm Show team, "it's even sold in nurseries under that brand name, with a price tag to match!"

To qualify for a worm bin you must be a resident of Vancouver and take a **"wormshop"** at City Farmer's Garden at 2150 Maple Street in Kitsilano. After the hour long hands-on session, participants walk away with their very own worm bin, including bedding materials, a shovel, a book by the Queen of Vermicomposting - Mary Appelhof, and a half pound of writhing, red wiggler worms (500!). All this for $25 - less than half the retail price!

"In this day and age, you can get overwhelmed by all that is wrong with the world. But we believe in the power of one," says Spring. "One worm eats its own body weight in food every day. By putting a worm bin on your balcony, or under your kitchen sink, you are demonstrating how much one person can do. Afterall, you're diverting at least a third of your garbage from the landfill. And you're setting an example that can ripple forth into the community."

Sign up for a wormshop by calling the Compost Hotline at **(604) 736-2250**. For

interviews, photos and to videotape the Black Gold Show, call Spring at the Hotline.

Go back to Urban Home Composting

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Composting with Redworms

Many homeowners have some kind of home composting system in operation. However, people living in condominiums, apartments and other residences don't have a suitable place to start a compost pile. These people feel left out on a worthwhile cause, and need alternative ways to be part of the composting program.

There is a solution! Kitchen wastes can be converted to a rich humus with the help of redworms. Children find worms fascinating. They are very well behaved "pets," and also help with household chores!

What to Call It

It is called a "home vermiculture system" or "worm box system."

The system contains

- **A physical structure: a redworm box or container**
- **Biological organisms: redworms and microorganisms & macroorganisms**
- **A controlled environment: temperature, moisture, acidity**
- **A maintenance program: bedding preparation, food waste burying, separating redworms from compost and using compost**

Where to Put It

Consider the needs of redworms and needs of the owner. Redworms need controlled temperature, contolled moisture content, controlled aeration and proper pH.

Temperature:

Redworms tolerate a wide range of temperatures, however, the ideal temperature is between 55 – 77 degrees F. Bedding with a temperature above 84 degrees F. is harmful, sometimes fatal, to redworm populations. The temperature should be measured inside the box, because the temperature in the moist bedding is usually lower than the outside air.

Redworms should be protected from freezing temperatures. Temperatures below 50 degrees F. slow down worm activity.

Moisture Content:

Redworms need a moist environment. Worms breathe through their skin. Skin must be moist in order to breathe.

Aeration:

Redworms need oxygen to live. They produce carbon dioxide. Air circulation is a must in and around a worm box.

pH level:

Redworms do best if the pH is around 7.0, however, they can tolerate levels from 4.2 to 8.0 or higher. Lime (calcium carbonate) may be mixed with the bedding material to correct acidity or to maintain a more favorable pH. Pulverized edd shells also correct acidity. (Warning! Use only limestone and never hydrated lime. The wrong kind of lime will kill the worms!)

Owner Needs

1. **Convenience for maintaining the wormbox**
2. **Aesthetic preferences: Kitchen? Garage? Basement? Or Bedroom??**

What Kind & Size Container?

Shape:

The box or container should be shallow, not more than 1 1/2' deep. Redworms tend to feed in the top layers of bedding. Materials may pack down if spread too deep.

Size:

Size depends on the average pounds of kitchen waste per week. A box measuring 1' by 2' by 3' can handle 6 pounds of kitchen waste, which is the average for families from 4 to 6 people. A smaller sized box, 1' by 2' by 2', can handle kitchen waste for 2 people.

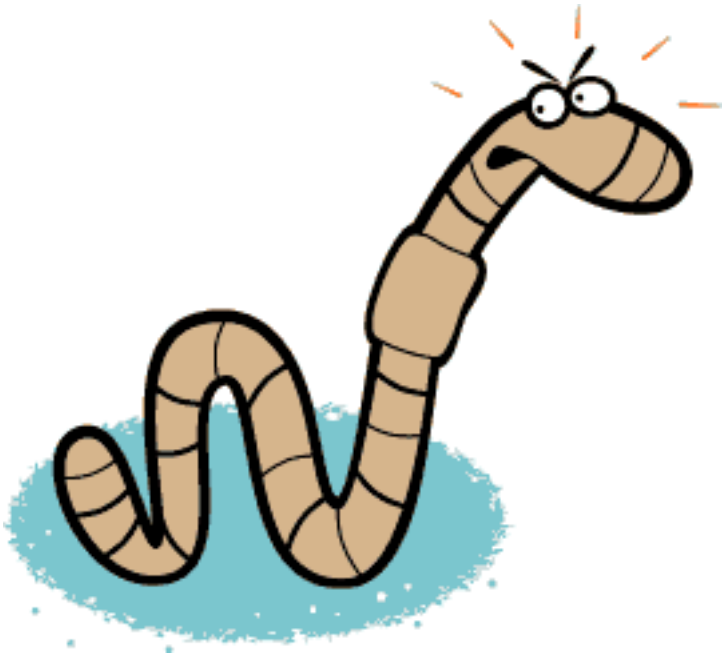
Material:

Never use a recycled container that might have been used for chemicals! Treated wood could be harmful, also. Some examples of good materials to use might be:

- **Wooden pallets**
- **Old Rubbermaid containers**
- **Old ammunition boxes**
- **Go to the Re-store for ideas!**

Bedding:

1. **Corrugated cardboard is an excellent material for bedding. Be careful not to breathe in the dust if you shred it. Corrugated cardboard holds moisture better than any other material. Some people use a piece of corregated cardboard to cover their bedding. In a "wet" environment, it can help to absorb some liquid, and will eventually disinegrate.**
2. **Shredded newsprint and computer strips can be used. The papers should be shredded in long lengths of ¼" wide strips. It's easily moistened, but the strips don't keep the moisture as well. Strips provide more surface area from which the water can evaporate. They require frequent moistening. The black ink used for printing the newspaper is not toxic to redworms. The main ingredients of black ink are carbon and some oils. Colored ink should be avoided. There used to be heavy metals, such as lead and chrome, in colored ink. US Government regulations now forbid the use of heavy metals in colored ink for printing newspapers.**
3. **Shredded newspaper is the most economic material. Make the strips from one to two' long by ½ to 1" wide. Redworms will eat the paper after it has softened.**
4. **Some people may object to the initial odors of animal manures. It is not recommended to use manures if the box will be located in your living area! Animal manures have other organisms such as mites, sowbugs, centipedes or grubs that you wouldn't want in your home. But if the box will be outside or in a garage, manures would be fine. Worms really like manures. Reminder—no pet, people or pig manures!**
5. **Old decaying leaves are a good source of bedding. Some leaves are better than others are. For example, maple leaves are preferred over oak leaves, because the latter take longer to break down. Leaves from trees growing along heavily traveled roads could be dangerous because of possible lead accumulation on the leaves.**
6. **Peat moss can be used if mixed with other bedding materials. It has an excellent moisture holding capacity, however it provides no nutrients for the worms, and can be expensive.**
7. **A handful of soil provides the grit worms need for breaking down food particles within the gizzard. Since worms don't have teeth, their food must be broken down by muscle action in their gizzards.**



Worms With "The Right Stuff"

REDWORMS:

Eisenia Foetida

This variety is the best redworm for home composting. They produce a large amount of compost in their natural habitats of leaves, manure, compost piles and in many other decaying organic materials.

Lumbricus Rebellus

This variety will adapt to the worm box environment, but they are really a soil earthworm. Their natural habitat is in soils which contain a lot of organic matter.

Redworms are on the market under many different common names. Some people call them "red wigglers," or "manure worms." Fishing suppliers may call them "red hybrid," "dungworm," or "striped worm." All these names are for the same kind of redworms. If you order from commercial breeders, your best choice is Eisenia Foetida. This variety is used by many for worm composting projects. The Cooperative Extension office has names of suppliers.

OTHER WORMS:

Worms NOT to use:

Lumbricus terrestris

This is the night crawer. This variety is the most studied of all earthworms and most sold to farmers and gardeners. They are very important for soil improvements and are widely raised for that purpose. They like to tunnel in the soil, sometimes 3 feet deep. They come

to the surface foraging for organic matter, which they take into their furrows. They mix sub-soil with their food and deposit their castings on the surface. Their burrows aid in soil aeration and allow for better water penetration. Nightcrawlers have a very important role in our ecosystem but don't adapt to the shallow worm box environment.

Garden worms:

There are more earthworm varieties that might show up in somebody's garden. To identify worms you have to count the segments, study their sexual organs and their behavior. It's best to stay with redworms for your worm box.

The Sex Life of a Redworm

Hermaphroditic:

Redworms have both sexes, but mating is still necessary. If the worm has a swollen band, called the clitellum, at about one third between head and tail, this means that the worm is sexually mature. Redworms mate in their bedding at different levels, sometimes even on the surface. They may mate at any time of the year. They are attracted to each other (maybe for their beautiful body face, or other irresistible qualities.) They find each other and lie with their heads in opposite direction, bodies closely joined. They produce a secretion and secrete this through their clitella, a mucus that forms a band around each of them. Sperm from each worm move down a groove into receiving pouches of the other worm. The sperm enters in a storage sac. Some time after the worms have separated, the clitellum secretes another substance called albumin. This material forms a cocoon in which the eggs are fertilized and baby worms hatch.

Redworm cocoons are round shaped and small. They change color during their development, first white, becoming yellow, later brown. When new worms are ready to emerge, the cocoons are turning red. It takes at least three weeks for the worms to develop in the cocoon. Temperature and other conditions are factors in the development of the hatchlings. Although a cocoon might hold as many as 20 eggs, usually only 3 or 4 worms will emerge. The young hatchlings are whitish with a pink tinge showing their blood vessels.

Population Control

Conditions that determine Redworm population:

If worms have to compete for food, the population will go down. If there is a lot of food available for a time, then worms multiply at a high rate and more young worms then compete with their parents. Then this greater population produces more castings. To solve the problem you can feed them more food, but you might also need a larger box for the greater numbers of worms. It's important to note that castings are toxic to their own species, so it is advisable to harvest the castings regularly.

How many worms to start with?

The number of redworms needed depends on the daily food waste. There is a worm to daily food ratio. The ratio is 2 pounds of earthworms for each pound of food, in short: 2:1.

For example, 1 lb. Worms can eat 3.5 lbs. Food waste per week, or .5 lb. per day.

How many redworms there are in a pound of worms depends on the size of the worms. Commercial growers estimate that there are 1000 breeders (sexually mature) in one pound of worms. A dealer in baits for fishermen expect not more than 600 worms per pound, otherwise his buyers might complain. New hatchlings are very small, and sometimes 150,000 are needed to make one pound. If you order pit-run worms (worms of all sizes and ages) by the pound, you will have lots more worms than if you should order breeders by the pound.

Setting up a Worm System

You need:

1. **A worm box**
2. **Bedding**
3. **A couple of handfuls of soil or sand**
4. **A scale, if you want to know how many pounds of food waste you have.**
5. **Moisture. Worms' bodies & the bedding should have the same amount of moisture content. This amounts to 75% to 90% moisture content.**

Water: Bedding ration = 3:1 by weight. Three pounds water to one pound bedding.

If using dry bedding such as shredded paper, newspaper strips or cardboard, you need to wet it. One way is to put the material in a bucket and add water to it, until it is saturated. (That would be about a minute or two.)

Manure bedding:

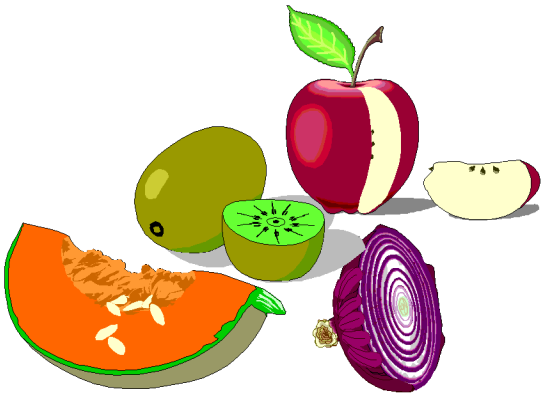
If using composted manures, it is more difficult to determine moisture. Be careful not to make the manure soggy! If the manure is too soggy, add some dry material to it, such as shredded paper cardboard or leaf mold. The goal is to keep your worm bin under aerobic rather than anaerobic conditions.

Moisture & Temperature:

A few drops of moisture released by squeezing could be a guideline for the right amount. If five or more drops are produced the material is too wet. The ideal temperature for worms is between 55 and 77 degrees Fahrenheit.

Adding worms to bedding:

When bedding is ready for the worms place the worms on top. They will disappear in a short time in the bedding. They don't like light. By keeping some bright light close by the box the worms will disappear faster in the bedding. If some stay on the surface after some time, assume that they are unhealthy or maybe dead, and remove them.



Food:

Most kitchen waste or table scraps, any vegetables, grapefruits, orange rinds, apple peels, lettuce and cabbage, celery ends, spoiled food from the refrigerator, coffee grounds, tea bags, egg shells are all suitable worm meals. (Remember, no meat or dairy products belong in a worm bin.)

Don't use meat or milk products in the worm bin. Mice and rats could be attracted to the odors!

Also, non-biodegradable materials don't belong in a worm box.

Cat litter should not be used, either. The odor of cat urine is intolerable to worms, plus the ammonia in the urine could kill the worms! Cats can carry the disease Taxoplasma gondii. This can transfer to humans. For example, a pregnant woman could inhale some of the protozoan and pass the disease on to her fetus, causing birth defects.

Burying kitchen waste:

One way to manage a worm box is to pick a different spot to bury kitchen waste in the box. A 2'x2' box has approximately nine locations where you can bury wastes. That gives you nine feedings before you have to repeat the cycle.

You need some air circulating in the box, or bad odors could occur.

Worms will usually like the earlier buried food wastes. They like decaying organic wastes best. They do not always wiggle to the newly added fresh food waste. They like the bacteria, fungi, and protozoa to break it down first! Worms help keep the decaying material aerobic and help keep conditions free of odors. They produce castings at the same time.

There are many other techniques for adding kitchen wastes, which vary with owner preference and the type of box or container. Some people may just have worms in a garbage can with holes drilled on the sides for aeration. Some bury this foot deep in the

back yard, and worms can come in and out as conditions vary. They just throw the kitchen wastes on the surface. (Make sure you have a tight lid that is racoon proof!) They may add some materials such as sand, soil or peat moss on top. Just be sure not to fill it too high with food and bedding, or it will pack down and may become anerobic. Whatever works for the specific situation is fine—provided there are no odors or other problems.

Grind food waste?

Grinding food waste is extra work. These kitchen wastes break down in a very short time. Eggshells should be pulverized. Although redworms have very tiny mouths, and ground food would be easier for them, we want them to help us with kitchen waste! Too much time and energy spent preparing their food can be discouraging.

Overloading the system

The size of box and amount of worms are deciding factors for how much food should be put in the box. Remember the 2:1 ratio for worms. Two pounds of worms is needed for one pound of food per 24 hours. The surface area of the box should be 7 square feet if 7 pounds of waste in one week is consumed.

If too much kitchen waste is produced on certain occasions, the wastes could be temporarily stored in another container for use later. An overloaded worm box can become anaerobic, and stinky! If that happens, don't add any fresh kitchen waste. If you leave it alone for a while, the situation will correct itself.

Do I need a worm sitter?

If you're going on a vacation, you could feed the worms a little extra just before you leave. This is the best part of having worms as pets! Feed them and leave them undisturbed. This way, you can go away for weeks. If you leave for longer than 3 weeks, it might be good to have a worm loving friend come and feed them once.

Observe the worms

The less you disturb worms, the better off they are. However, you should make regular observations to know what is going on in the box. The best time to do this is at feeding time. Is the bedding still moist? Is the temperature inside the box between 55-77 degrees? Sometimes you find many worms at one spot in a feeding frenzy. Note what they like and don't like. Look for worm eggs and baby worms. Are there any mating worms? Worms usually fascinate children. It is a good science project for children. However, point out to the children that the worms don't like to be too much or too often disturbed. They can't tolerate bright light. A red light could be practical for observations of the worms.

Different foods for different worms

Younger worms often are all congregated by a certain food item. Older worms sometimes are feeding on another. Older worms love to fill up the inside from halved grapefruits or oranges.

Recording observations

You can keep records of your experiences and improve your skills by sharing knowledge with others. Many people are interested in "vermiculture." You may be called on for information on composting with worms.

Harvesting castings and changing bedding

After weeks of adding food wastes the bedding goes down. This is a combination of worm activity and the microorganism activities. Decomposition and composting are taking place. The color of bedding becomes darker. The favorable environment for the worms decreases. The large amounts of castings might become harmful to the worms. Castings of one worm are toxic to another worm.

When to change the bedding depends on the bedding used, the quantity of the earthworms in the box, temperature and moisture conditions. Four to six months is a good guess for keeping the same bedding, if the worm boxes are correctly maintained.

Let the worms do the sorting

If you prefer only to add some new fresh bedding, carefully move the old bedding to one side of the box. Add the fresh bedding in the open space and start feeding in the new bedding.

Divide and dump technique

To divide the worms from the old bedding, dump the contents of the worm box on a sheet of plastic or a table. The worms will go down in the pile if you expose them to light. After a short time remove the top layer of the bedding up to the point you encounter worms. Wait a short time, and continue removing the bedding. You will end up with lots of worms in a small pile. If too many worms are left, some could be supplied for starting another box.

Frequently Asked Questions

Can they see?

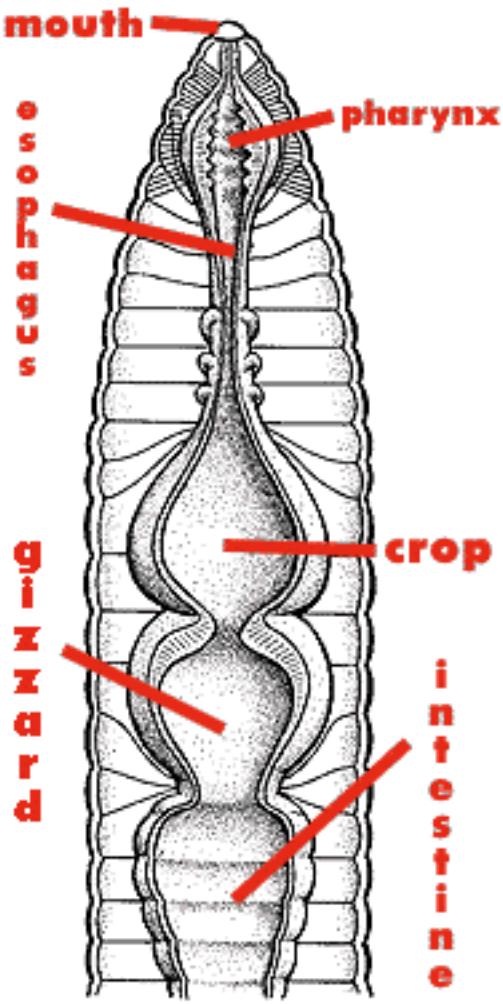
No, worms don't have eyes. However, they must have some kind of light sensor. They are very sensitive to bright light. They will try to hide as soon as exposed. It's odd that anglers use a flashlight to catch night crawlers, since they retract in their burrows if you shine lights on them. Worms are less sensitive to red light. You can observe worms with red light. Placing a red cellophane between the light source and the worm box allows you to watch the worms.

Where is the mouth?

The worm's mouth is in the first anterior segment. There is a small protruding lip just over the mouth, called prostomium. When the worm is foraging, this lip is stretching out. The prostomium is for sensing food.

Do they have teeth?

Worms have no teeth for chewing food. They grind food in their gizzard by muscle action



How do they grind food?

Worms can only take small particles in their small mouths. Microorganisms soften the food before worms will eat it. Worms have a muscular gizzard. Small parts of food mixed with some grinding material such as sand, topsoil or limestone is ingested. The contractions from the muscles in the gizzard compress those particles against each other, mix it with fluid, and grind it to smaller pieces.

What happens to food once it leaves the gizzard?

The ground up food is mixed with enzymes in the worm's intestine. This mixture breaks down the food, molecules pass through the intestine wall into the bloodstream for use where needed. Undigested material, including sand soil, bacterial and plant residues passes out of the worm as a worm casting.

If a worm is cut in to, will it grow back?

It depends on where the cut took place. If a worm is cut at the posterior end, sometimes a new tail will grow back on. Sometimes a second tail will appear next to a damaged tail. However, the posterior half of the worm can't grow a new anterior (head.)

Do worms die in the box?

It's hard to find dead worms in a worm box, but they do die in the box. Dead worm bodies decompose very quickly, because their bodies are between 75%-90% water. If you find many dead worms you should find out the cause. High heat (above 84 degrees) is fatal to them. Too much salt or acidic food waste can kill them. It's best to change the bedding with fresh materials to solve the problem. Sometimes, partially replacing bedding may solve the problem.

How long do worms live?

Often, worms live and die in the same year. They are exposed to hazards, dryness, too hot or too cold weather. Eisenia foetida can live for as long as four years.

Do worms need air?

Worms need oxygen to live. The oxygen diffuses across the moist tissue of their skin, from the region of greater concentration of oxygen (air) to that of lower concentration (inside the worm.) Carbon dioxide produced by the bodily processes of the worm also

diffuses through skin. Moving from higher concentration to lesser concentration, carbon dioxide moves from the inside of the worm's body out into the surrounding bedding. A constant supply of fresh air throughout the bedding helps this desirable exchange take place.

More Questions? E-mail: joycej@coopext.cahe.wsu.edu

Whatcom County Agriculture Page | Whatcom County Home Page | Whatcom County Home Composting Page

Cheap and Easy Worm Bin!

Composting with redworms is great for apartment dwellers who don't have yard space, or for those who don't want to hike to a backyard compost bin with their food scraps. Some kids like to keep worms for pets! By letting worms eat your food wastes, you'll end up with one of the best soil amendments available—worm castings. This is the cheapest and easiest to manage worm bin system that I've seen:

Materials Needed to Make an Easy Harvester Worm Bin:

- Two 8-10 gallon plastic storage boxes (dark, not see through!) as shown in pictures Cost: about $5 each
- Drill (with 1/4" and 1/16" bits) for making drainage & ventilation holes
- Newspaper
- About one pound of redworms

Step 1 Drill about twenty evenly spaced 1/4 inch holes in the bottom of each bin. These holes will provide drainage and allow the worms to crawl into the second bin when you are ready to harvest the castings.

Step 2

Drill ventilation holes about 1 – 1 ½ inches apart on each side of the bin near the top edge using the 1/16 inch bit. Also drill about 30 small holes in the top of **one** of the lids.

Step 3

Prepare bedding for the worms by shredding Newspaper into 1 inch strips. Worms need bedding that is moist but

not soggy. Moisten the newspaper by soaking it in water and then squeezing out the excess water. Cover the bottom of the bin with 3-4 inches of moist newspaper, fluffed up. If you have any old leaves or leaf litter, that can be added also. Throw in a handful of dirt for "grit" to help the worms digest their food.

Step 4

Add your worms to the bedding. One way to gather redworms, is to put out a large piece of wet cardboard on your lawn or garden at night. The redworms live in the top 3 inches of organic material, and like to come up and feast on the wet cardboard! Lift up cardboard to gather the redworms. Or, if you wish to purchase worms, the Cooperative Extension office can give you names of suppliers in Whatcom County. An earthworm can consume about 1/2 of its weight each day. For example, if your food waste averages 1/2 lb. per day, you will need 1 lb. of worms or a 2:1 ratio. There are roughly 500 worms in one pound. If you start out with less than one pound, don't worry they multiply very quickly. Just adjust the amount that you feed them for your worm population.

Step 5

Cut a piece of cardboard to fit over the bedding, and get it wet. Then cover the bedding with the cardboard. (Worms love cardboard, and it breaks down within

months.)

Step 6

Place your bin in a well-ventilated area such as a laundry room, garage, balcony, under the kitchen sink, or outside in the shade. Place the bin on top of blocks or bricks or

upside down plastic containers to allow for drainage. You can use the lid of the second bin as a tray to catch any moisture that may drain from the bin. This "worm tea" is a great liquid fertilizer.

Step 7

Feed your worms slowly at first. As the worms multiply, you can begin to add more food. Gently bury the food in a different section of the bin each week, under the cardboard. The worms will follow the food scraps around the bin. Burying the food scraps will help to keep fruit flys away.

What do worms like to eat? Feed your worms a vegetarian diet. Most things that would normally go down the garbage disposal can go into your worm bin (see the list below). You will notice that some foods will be eaten faster than others. Worms have their preferences just like us.

Feeding your worms:

Worms LOVE	Worms HATE
Breads & Grains Cereal Coffee grounds & filter Fruits Tea bags Vegetables	Dairy Products Fats Meat Feces Oils

When the first bin is full and there are no recognizable food scraps, place new bedding material in the second bin and place the bin directly on the compost surface of the first bin. Bury your food scraps to the bedding of the second bin. In one to two months, most of the worms will have moved to the second bin in search of food. Now the first bin will contain (almost) worm free vermicompost. (You can gently lift out any worms that might remain, and place them in the new bin, or put them into your garden!)

Troubleshooting

Problem	Probable Cause	Solution
Worms are dying or trying to escape	Too wet Too dry Bedding is used up	Add more bedding Moisten bedding Harvest your bin
Bin stinks!	Not enough air Too much food Too wet	Drill more ventilation holes Do not feed for 1-2 weeks Add more bedding
Fruit Flys	Exposed food	Bury food in bedding

Check out Composting with Redworms for lots more information about caring for worms. If you want to use your carpentry skills, you can view plans for a wooden worm bin.

Want to know more?? E-mail: joycej@coopext.cahe.wsu.edu

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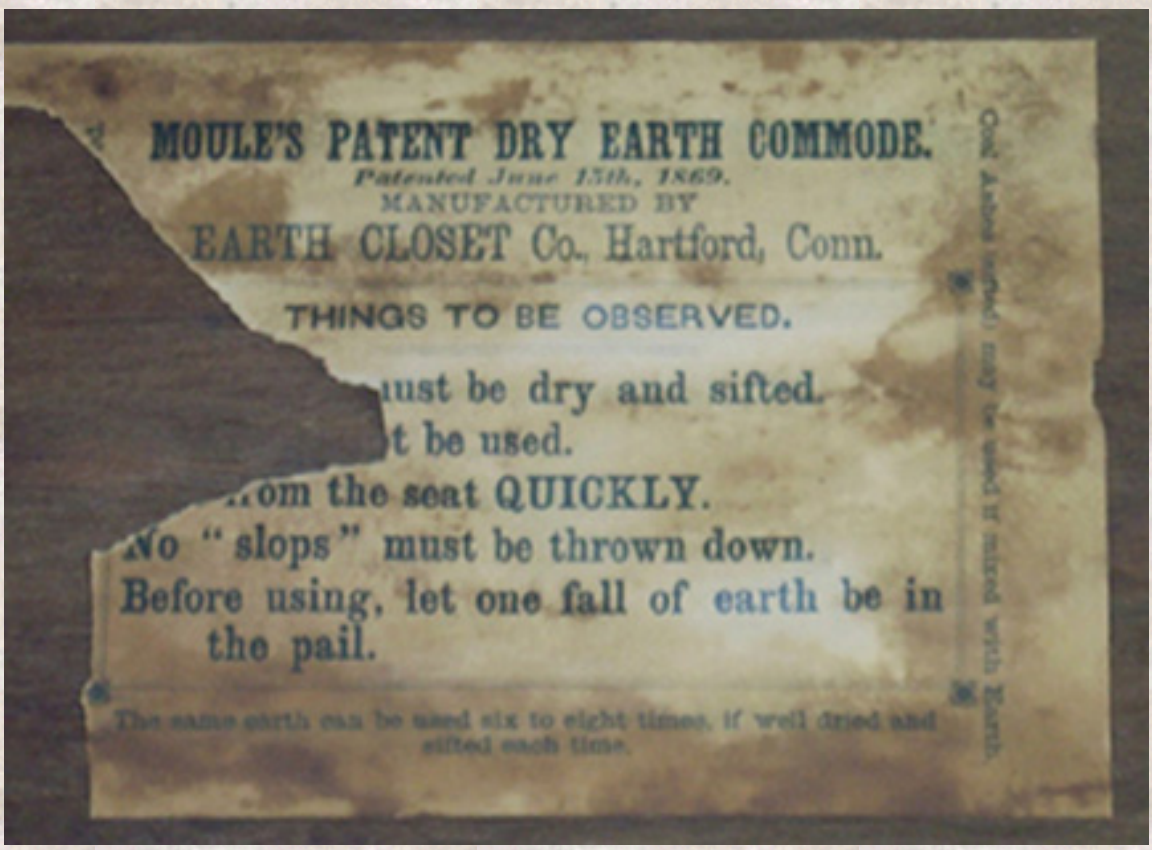
An Actual Earth Commode in Mint Condition

Moule's Patent Earth Commode" Pat. 1869
Photo from Mark Henderson (Used by permission)



Directions for using the Earth Commode/Closet
Photo from Mark Henderson (Used by permission)

A somewhat blurred view of the same Earth Commode Directions
Photo from Mark Henderson (Used by permission)

Once in a while someone sends me some unbelievable photo's showing something so significant it demands attention. Moule's Earth Commode is featured on my faq's page. I did not have any pictures of one; only drawings in a book. Here is what Mark found.

I just bought a home circa 1842 in CT and found this "earth closet" in the attic. It is an oak "Moule's Patent Earth Commode" Pat. 1869. It still has the directions and I thought you might enjoy reading them. Thanks for the history lesson....I just don't know what to do with the "closet". The commode is in pristine condition.

Here are what the directions shown above say:

Things to be observed:

1. The Earth must be dry and sifted.
2. Sand must not be used.
3. Rise from the seat QUICKLY!
4. No "slops" must be thrown down.
5. Before using, let one fall of earth be in the pail.
6. To find out more information on the Earth Closet, click HERE.

What else can you see in the images shown? Many times a photo is worth a thousand words and I've only elaborated with a few so here is your chance to add some "color commentary" to my collection. If your addition is worthy, you will find the quote added on the *Comments to the Curator* page. You can use Email to respond. If you choose to go to the Comments to the Curator page, be prepared to relax with a large beverage of your choice. The reading is spectacular!

Have you seen all the Outhouses yet?

Return to the Outhouse Tour by clicking HERE!

Stamp here to "dump" mail to the official Outhouse Curator...

Return to my home page...

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Issue 5, 15th January 1996: Henry Moule, Down to Earth

SCIENCE AND TECHNOLOGY

Links, heros, and stories from science and technology

By Adam Hart-Davis.

Topical, Science on the Web, Organisations, Magazines, Search tools, Back Issues, Other.

[Computing, Law, Science and Technology, SciFi, Sport, The Unexplained, UP]

Rev Henry Moule and the Earth Closet

An earth-closet is a lavatory in which dry earth is used to cover excreta. Until a hundred years ago, the traditional ``place of easement'' for people living in the country was either a privy with a cess-pit, or an earth-closet. The definitive book on the privy is Chic Sale's ``The Specialist.''

In Britain, Queen Victoria used an earth-closet at Windsor Castle, although many types of water-closet were available. For many years, the earth- and water-closets were rival systems with champions and detractors on both sides.

Henry Moule, champion of the earth-closet, was born in Melksham, Wiltshire, on 27 January 1801, the sixth son of a solicitor. He went to Cambridge, and in 1829 became vicar of Fordington in Dorset, where he remained for the rest of his life.

(Also born 1801: Robert Dale Owen, American social reformer and politician; Sir Joseph Paxton, English architect who designed Crystal Palace; Fredrika Bremer, writer, reformer and champion of women's rights; Vincenzo Bellini, Italian operatic composer who influenced the likes of Wagner and Chopin; Brigham Young, second president of the Mormon church.)

For some years he was chaplain to the troops in Dorchester Barracks, and from the royalties of his 1845 book ``Barrack Sermons'' he built a church at West Fordington.

In 1861 he produced a 20-page pamphlet entitled National health and wealth, instead of the disease, nuisance, expense, and waste, caused by cess-pools and water-drainage. ``The cess-pool

and privy vault are simply an unnatural abomination," he thundered, ``the water-closet ... has only increased those evils." And he went on to describe his own amazing discovery.

In the summer of 1859 (I think) he decided his cess-pool was intolerable, and a nuisance to his neighbour; so he filled it in, and instructed all his family to use buckets. At first he buried the sewage in trenches in the yard, one foot deep, but he discovered by accident that in three or four weeks ``not a trace of this matter could be discovered." So he put up a shed, sifted the dry earth beneath it, and mixed the contents of the bucket with this dry earth every morning. ``The whole operation does not take a boy more than a quarter of an hour. And within ten minutes after its completion neither the eye nor nose can perceive anything offensive."

Then he discovered that he could recycle the earth, and use the same batch several times, and he began to grow lyrical. ``Water is only a vehicle for removing it out of sight and off the premises. It neither absorbs nor effectively deodorises.... The great ... agent ... is dried surface earth, both for absorption and for deodorising offensive matters." And, he said, he no longer threw away valuable manure, but obtained a ``luxuriant growth of vegetables in my garden."

He backed up this last point with a scientific experiment, persuading a farmer to fertilise one half of a field with earth used five times in his closet, and another with an equal weight of superphosphate. Swedes were planted in both halves, and those nurtured with earth manure grew one third bigger than those given only superphosphate.

Moule quoted a biblical precedent for his efforts, from a set of instructions about cleanliness: ``And thou shalt have a paddle upon thy weapon; and it shall be, when thou wilt ease thyself abroad, thou shalt dig therewith, and shalt turn back and cover that which cometh from thee." (Deut. 23:13) The New English Bible is even clearer: ``With your equipment you will have a trowel, and when you squat outside, you shall scrape a hole with it and then turn and cover your excrement."

According to Moule, doctors said that if his scheme could be generally adopted, ``much more would be effected by it for the prevention and check of disease and sickness, and for the improvement of health, than Jenner has effected by the discovery of vaccination."

About 1850, some people in England brought the earth-closet inside the house, and various patent mechanisms appeared, the first by Thomas Swinburne in 1838 (No 7810). In 1860 Henry Moule produced a sort of commode with a bucket below seat, and a hopper behind it containing fine dry earth or ashes. When you had finished you pulled a lever to release a measured amount of earth into the bucket and cover the contents.

In partnership with James Bannehr, agent, Moule took out a patent in 1860 (No 1316)---and others in 1869 and 1873. He set up the Moule Patent Earth-Closet Company (Limited), which manufactured and sold an earth-closet for every occasion, the expensive models in mahogany and oak. ``They are made to act either by a handle ... or self-acting, on rising from the seat. The Earth Reservoir is calculated to hold enough for about 25 times, and where earth is scarce, or the manure required of extraordinary strength, the product may be dried as many as seven times and without losing any of its deodorising properties."

The closet was often inside a shed or privy, which provided some privacy and protection from inclement weather.

Parker's Patent ``Woodstock'' Earth Closet had similar automatic mechanisms triggered either by the release of pressure on the seat---so that it `flushed' when you stood up---or by pressing a foot lever.

W Liddiard invented another ``Patent Self-acting Foot-board'' to discharge the earth. He also patented a commode ``particularly adapted for use in-doors,'' and a multi-seater earth-closet for use in schools. Any number of units could be bolted together, side by side, and the earth-releasing mechanism operated from a distance, so that children could be prevented from playing with the device and wasting the earth!

An 1873 dry-ash commode could be filled straight from the fire-gate. The cinders were automatically separated and kept for reburning, while the fine ash covered the contents of the bucket every time the lid was raised. A later version had a removable drawer instead of a bucket, rather like some chemical lavatories today.

In the 1960s, my father had an earth closet in a tiny shed outside his remote holiday cottage in Yorkshire. He issued strict instructions not to pee in it, since urine would make it smell; ``Go out on the hillside,'' he said. However, Moule claimed that the dry-earth principle is applicable to urinals, and ``especially suitable for schools and railway stations and other public places ... all offensive smell may be prevented, and a valuable manure manufactured.''

I had thought the earth-closet was a bit of a joke, but Moule was convinced that it represented the future. He worked out the implications; if used by six persons daily the earth-closet would require on average one hundredweight (50 kg) of earth per week, which he recommended should be dried in an iron drawer under the kitchen range. A town of 10,000 would need 16-18 tons of earth per day---but only borrowed!

He wrote a string of tracts and pamphlets, including ``The advantages of the dry earth system'' (1860), ``The impossibility overcome: or the inoffensive, safe, and economical disposal of the refuse of towns and villages'' (1870), ``The science of manure as the food of plants,'' and ``Manure for the million---a letter to the cottage gardeners of England.'' He also tried hard to get government support, with an 1872 paper on Town refuse---the remedy for local taxation. The substance of his argument was:

- *``There can never be a National Sanitation Reform without active intervention by central government.*
- *That active intervention can never take place under the Water Sewerage System, without a large increase of local taxation.*
- *But let the Dry-Earth System be enforced... and with a vast improvement in health and comfort, local taxation may be entirely relieved.''*

He managed to convince a lot of people. The medical journal The Lancet of 1 August 1868 reported that 148 of his dry-earth closets were used at the Volunteer encampment at Wimbledon---forty or fifty of them used daily by not less than 2000 men---without the slightest annoyance to sight or smell.

The Field of 21 November 1868 said ``In towns or villages not exceeding 2000 or 3000, we believe the earth-closet will be found not only more effective, but far more economical, than water

drainage."

This combination of economy and health was powerful. In 1865 the Dorset County School at Dorchester, with 83 boys, changed from water-closets to earth-closets, and cut the annual maintenance costs from GBP3 to 10/- (GBP0.5)! At the same time smells and diarrhea were eliminated. Lancaster Grammar School brought in earth-closets because the water-closets were always out of order ``by reason of marbles, Latin grammar covers, and other properties being thrown down them."

For some decades in the second half of the nineteenth century, therefore, the earth-closet and the water-closet were in hot competition. Almost everything Moule said was true, and much the same arguments are used today by the champions of bio-loos and composting lavatories. The environmental considerations have not changed; using water-closets is expensive, and merely shifts the problem downstream---the sewage has to decompose somewhere.

Henry Moule died in 1880, but even in his seventies he was still trying to persuade the British government that the earth-closet was the system of the future, and he nearly succeeded. Nevertheless in rich countries, because it does rapidly and effortlessly remove the sewage from the house, the water-closet has won the battle---so far...

LINKS

The symbol `N' indicates the site cannot be successfully viewed without Netscape 1.1 or above.

Topical

Find out about my new TV series, Local Heros about more of my heros of science and technology---I had nearly 2 million viewers for each of the first two shows! The Galileo homepage; keep abreast of the latest data from Jupiter (latest as of 96/01/22, the probe data is very good but confounds many current theories).

Science on the Web

The London Science Museum, and their list of other museums on the Web, Scientific Web Resources.

Magazines **UPDATED**

Yahoo's science-magazine section, and the science and technology magazines; the Franklin Institute's bulletin (weekly), NatureN (one of the world's main scientific journals, all areas of science), New ScientistN (UK science newspaper).

Search tools

Yahoo's science section. Searches by word: AltaVista, OpenText, WebCrawler, Yahoo, Lycos, InfoSeek, SavvySearch (searches multiple indices at once, but *slow*). Other searches: INFOMINE (The University of California's ``Physical Sciences, Engineering, Computer

Science and Math search tool"). Yahoo's history section.

Scientific Organisations and Institutions NEW

NASA (home page, Jet Propulsion Lab (JPL)), Royal Society of Chemistry (UK's principal chemistry body).

Back Issues

1995 December: 4 (Thomas Challoner, Alum Alumnus), November: 3 (Thomas Crapper, Fact and Fiction), October: 2 (Richard Arkwright, Cotton King), September: 1 (Henry Bessemer, Man of Steel).

Other links

alt.folklore.urban USENET FAQ (urban legends and their verity), Portraits of the famous (University of Texas, USA), Adam's home page.

BOOKS

Related books by this author:

- **Don't just sit there!**, Corgi Carousel, 1980.
- **Where there's life...** (with Hilary Lawson), Rainbird/Michael Joseph, 1982.
- **Scientific Eye**, Bell & Hyman, 1986.
- **Mathematical Eye**, Unwin Hyman, 1989.

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Hong Kong to Cape Town Overland

The Utilization of Municipal Wastes in South Africa

by J. P. J. van Vuren, M.Sc. (Agric.)

Farming and Gardening for Health or Disease
by Sir Albert Howard, 1945, Faber and Faber Limited

Appendix C

LITTLE was it realized in August 1939, when the first sod was turned for the excavation of an experimental compost pit somewhere on the boundary of the Ficksburg town commonage, that history was being made. Had this been known at the time, the criticism and prejudice which had to be faced and fought for so many months to come would then have mattered even less than they did.

Up to that time hardly anybody in the country had shown any practical interest in the conversion of otherwise useless and obnoxious products such as garbage, night soil, etc., from urban areas. My own knowledge of this subject was limited to a mere study of the results obtained overseas by men like Howard, Wad, Watson, Jackson, and others. I felt thoroughly convinced, however, that this method could be successfully employed in South Africa if only one municipality could be persuaded to co-operate in the initial experiment or demonstration.

About the time referred to above the author was transferred to Ficksburg in the Orange Free State, a small town with a population of scarcely 3,000 Europeans and situated on the border of the Basutoland Native Territory. On my arrival in my new sphere of activity the matter was discussed with the local health inspector, who at once declared himself willing to co-operate in the laying down of an experiment.

At first a small-scale trial was conducted, well away from the public eye and almost in secret. No funds were available. Ordinary trenches 12 x 8 x 2 feet deep, were dug in the soil and old pieces of scrap corrugated iron were cut, perforated, and used over drainage channels in the floor of the pit. Dry refuse straight from the tipping wagons was dumped in the pit and levelled into a layer about fifteen inches deep. On the top

of this came night soil, followed up with refuse and so on until in about three days' time the pit was filled. Right from the outset problems and numerous difficulties were encountered. Owing to poor drainage and the absence of aeration facilities the contents of the pit became a cold, sloppy, reeking mass. Consequently none of the labourers, whose customary task it was to dig trenches for the usual burial of night soil, could be persuaded to do the necessary turning over of the contents -- and they could hardly be blamed for refusing. The sides of the pit caved in during subsequent rains and myriads of flies issued from the sodden mass. Fortunately very few outsiders knew at that time what was happening, otherwise our experiment might have ended in court.

However, where there's a will there's a way. Our mistakes were gradually rectified and one after the other our problems disappeared until the stage was reached when an invitation to certain members of the Council could be risked. Their visit had the desired effect and a small sum of money was granted for the erection of proper brick and cement installations. In these new pits, erected according to Watson's Tollygunge plans as described by Sir Albert Howard in his pamphlet, *The Manufacture of Humus from the Wastes of the Town and the Village,* excellent results were quickly obtained. Temperatures started to climb to surprisingly high levels. Fly- breeding was prevented by these high temperatures and within four weeks the final product was a dark crumbly mass with no unpleasant odour and without any trace of its original constituents.

At this stage the local authority became convinced of the practicability of the composting process and it at once decided that this 'modern' method of urban refuse disposal should receive more sympathy and support. It was consequently decided that a more convenient site should be selected and the scheme extended to include at least fifteen pits instead of only two as was the case up to that time. The ultimate site selected was situated only half the distance from town of that where night soil had been regularly buried for over fifty years, the period of Ficksburg's actual existence. The Council at once realized that a considerable saving on transport would result quite apart from the fact that the final product might be sold, thereby increasing the revenue of the town and consequently reducing the cost of refuse disposal.

Based on the valuable experience gained during the experimental stage of the scheme, the new pits were built accordingly. Certain modifications were introduced and these included the following: an increase in the number of cross channels in the floor from two to seven; vertical side walls instead of sloping ones; an increase in the length and width of the pits and also in the gradient from one end of the pit to the other, the latter to facilitate the handling and distribution of night soil. In addition a shed was erected to protect the final product against wind and weather.

From then on practically all night soil and refuse from the urban area was removed to this new site, where it was turned into compost at the rate of about 100 to 150 cubic yards per month. The refuse included, more or less, the following: the contents of

garbage bins minus the coarse pieces of unburnt coal and other refractory material which are screened out on arrival at the site; weeds; grasses; hedge clippings; stable manure; papers; rags; abattoir refuse such as paunch contents, portions of the intestines, rejected meat or organs, blood, etc. (horns, hoofs, and bones were also collected but sold directly to bonemeal and fertilizer factories); sawdust; street sweepings, fallen leaves, etc. No longer were these constituents allowed to be dumped somewhere along the approaches of the town where rats and flies could breed unmolested. Instead, they were henceforth carted to one depot and there rendered harmless by being properly composted.

This, briefly, is the history of composting at Ficksburg. It may, however, be stated unhesitatingly that without the undaunted assistance of Mr. H. G. Williams, the Health Inspector at the time, as well as the sympathetic co- operation of the Ficksburg Town Council (through the medium of their energetic and capable Town Clerk), it is doubtful whether the scheme would ever have developed into the great success it is to-day. Without their valuable assistance Ficksburg would just have remained an ordinary Free State town, whereas to-day it is well known, not only in this country but overseas as well, as one of the pioneers in the direction of urban waste utilization.

No sooner were the first articles published in connection with the preliminary experiments at Ficksburg than inquiries started to pour in from various parts of the Union of South Africa, Rhodesia, Belgian Congo, and East Africa. At the same time a host of visitors were received and shown over the scheme at Ficksburg. According to the correspondence received, most of the urban authorities seemed to be faced with the same problems and difficulties of refuse disposal. This process of composting and getting rid of such material sounded to them like an answer to their prayers with the result that they were anxious to obtain details in regard to the process as quickly as possible. It did not then take long for the process to become adopted by various centres in southern Africa.

Owing to the fact that South African soils are generally deficient in phosphates, this country is dependent for her phosphate supplies from overseas. When war broke out, shipping facilities were reserved for the importation of essential war supplies. Imports, as far as this commodity was concerned, dropped to about 50 per cent of the pre-war supplies. At the same time there was an increased demand for food at this stage when farmers could obtain only half the normal requirements of fertilizers. As a result of this shortage all possible avenues of obtaining fertilizing material in the country were explored. Farmers were encouraged to give more attention to neglected manure heaps on their farms and to conserve and use this valuable material more extensively than in the past. In addition, farm composting methods were demonstrated and encouraged. Bat manure and phosphate deposits were explored and in some cases made available to farmers in the crop-producing areas. At the same time a huge trade developed in sheep and goat manure from the Karoo, South Africa's principal small-stock area, ultimately reaching such proportions that it was feared that the supplies would not outlast the war. In spite of the exploitation of all these sources of supply, it was still felt that production might suffer from a shortage of the necessary

fertilizer material. It was the imminence of this possibility which caused greater attention to be given to the preparation of urban compost. If vegetable and fruit farmers, it was thought, could be encouraged to use urban compost more extensively, then more of the mineral fertilizers would be available for use in the production of grain crops such as maize and wheat. The possibilities of urban compost fulfilling part of this programme were investigated by a special Departmental Compost Committee on whose advice the Department of Agriculture and Forestry decided to institute an urban compost campaign on a national basis, the author being appointed co-ordinating officer for the scheme for the duration of the war. To assist him, six other officials, stationed throughout the four provinces of the Union, were also designated for this work. The duty of these officers was mainly to visit each urban centre in their respective areas and to encourage the adoption of the composting process.

For the purpose of gaining first-hand knowledge and experience of the process, these regional officers met at Ficksburg in August 1942, immediately after the decision to inaugurate this scheme. Apart from studying the method in its various aspects, these officers in conjunction with the co-ordinating officer drew up a programme of action so as to ensure the co-ordination of advice and policy. This programme included the following:

1. The co-ordinating officer was to draw up a specified plan of the pits, as well as a pamphlet describing the Ficksburg composting process in detail, and to issue these to the regional officers for distribution to municipalities in their areas.
2. Until such time as the co-ordinating officer was available to accompany each regional officer in turn through his area, these officers were to leave no stone unturned in so far as preliminary propaganda in this connection was concerned. At about this time the annual Municipal Conferences were to be held in the different provinces and they had to be addressed on the subject. Articles were to be written and published in local papers, etc.
3. By this time there was at least one centre in each of the six areas where the process had been adopted already. At such centres regional officers were to organize two-day short courses for representatives of neighbouring towns. On these occasions practical demonstrations and lectures were to be given so as to make such representatives as thoroughly conversant with the process as possible.
4. Radio talks and articles for the daily press were to be drawn up or circularized.
5. Certain aspects of the process warranted further investigation and in particular the co-ordinating officer was to be responsible for the carrying out of this work at Ficksburg.

This, briefly, was the programme drawn up at the Ficksburg Conference in August 1942, and within six months practically the whole of the Union with its 300 municipalities and health boards was covered. It was soon found that almost all centres were confronted with the same difficulties and problems. Literally mountains of 'waste' were encountered at many places. These had accumulated over many years in some cases and it was not uncommon to see, lying in sight of these huge dumps,

lands where the soil had been worn down to a condition of total impoverishment. That this has been and is still going on in many centres of the Union even to-day is incontrovertible proof of the naked truth of the late Professor King's words, 'Man is the most extravagant accelerator of waste the world has ever endured.' Fortunately South Africa is a country of vast open spaces, otherwise dumping sites might have become so limited that many of these dumps of fertility would have had to disappear in clouds of smoke, instead of still being there to-day in a state in which their fertility is still partly recoverable if only urban authorities can be persuaded to render such material marketable in the form of refuse-dump screenings and compost. These 'humus mines' as Sir Albert Howard calls them, are in many instances ready for immediate use on the land and could contribute materially to a reduction in the existing shortage of fertilizers.

After two years since the inauguration of the compost scheme, the position in regard to its adoption in South Africa is as follows: (p. 253)

In the various provinces the following towns and cities have adopted the urban composting process:

Northern Transvaal: Nylstroom, Potgietersrust, Pietersburg, Messina, Hercules, Zeerust, and Pretoria (Indore compost).

Southern Transvaal: Potchefstroom, Klerksdorp, Ermelo, Brakpan, Heidelberg, Volksrust, Boksburg, Randfontein, Lichtenburg, Alberton and Johannesburg, Roodepoort, Maraisburg (Indore compost).

Orange Free State: Ficksburg, Ladybrand, Clocolan, Bethlehem, Harrismith, Vrede, Reitz, Heilbron, Parys, Kroonstad, Kopjes and Bloemfontein, Kimberley (Indore compost).

*Natal:*Matatiele, Glencoe, Stanger, Dannhauser, Vryheid, Howick, Margate, Darnall, Bergville and Durban, Pietermaritzburg (Indore compost).

Karoo and Eastern Cape Province: Aliwal North, Elliot, Fort Beaufort, Graaff-Reinet, Kirkwood, Kingwilliamstown, Prince Albert, Queenstown, Umtata, Walmer, Cradock, Dordrecht, Oudtshoorn, Uitenhage, Humansdorp and Beaufort West (Indore compost).

Western Cape Province: George, Parow, Goodwood, Wolseley, Stellenbosch, Mossel Bay, Bellville, Swellendam, Vredenburg, Heidelburg, Robertson, Tulbagh, Capetown, Rivier-Zonder-End, Franschhoek, Ceres, Worcester, Clanwilliam, Wellington, Porterville, Caledon and Malmesbury.

	Schemes in	**Average Annual**	**Total Production to**

Area	Production	Course of Construction	Production in Cubic Yards	date in Cubic Yards
Northern Transvaal	7	2	5,000	6,300
Southern Transvaal	12	1	13,500	18,600
Orange Free State	13	1	13,250	19,250
Natal	11	7	12,000	15,500
Karoo and Eastern Cape Province	16	6	5,600	12,100
Western Cape Province	22	6	21,000	27,000
Total	81	20	70,350	98,750

The main reasons why the remaining centres in the Union have not yet adopted the composting scheme are briefly the following:

1. Lack of sufficient capital to construct the necessary pits. The cost of constructing such pits varies from place to place, depending on the cost of material and labour, but anything from £15 to £20 per pit can be taken as an average. Villages and some of the small towns, looking at the matter more from a financial point of view, felt that the output might be so small that it would not warrant the expense.

2. Lack of sufficient quantities of raw materials, especially dry refuse, to absorb the liquids contained in the night soil. In some parts of the country, where the rainfall is low and poorly distributed, the vegetation is naturally scanty. This creates a real problem which cannot be disregarded. At the same time, the climate and type of farming in these areas are such that there is hardly a demand for compost, which means that this product would have to be exported to distant localities, thus raising the cost and leaving only a very small margin of profit, if any at all.

3. The decision of the Department of Labour that urban composting schemes should fall under the Factory Act. The application of this Act meant that the provisions of certain clauses applicable to modern, well- equipped factories had to be complied with. Although it was added in the proclamation that exemptions in certain respects could be granted, many centres did not see their way clear to adopt the process under such conditions.

4. Uncertainty in regard to the demand for the final product. This question was asked in practically every instance and the fact that the Department was not prepared to

guarantee either a price or a constant demand for the product made the scheme less attractive. There is, of course, always the possibility that the demand may decline after the war when supplies of artificial fertilizers will again be available. It is nevertheless felt that as the supplies of Karoo manure are being exhausted since the restriction of the importation of artificials, compost may take its place as a worthy substitute.

5. The mercenary attitude of many local bodies. In many cases town councillors were interested in the project only because they regarded it as a potential gold mine. When it was explained to them that they should at most hope for an appreciable reduction on the cost of night soil and garbage disposal, the scheme lost its attractiveness. Many of the municipal compost works are charging excessive prices in an endeavour to show clear profits. In their balance-sheets the costs of disposal under the old system are usually ignored and the national service that is being rendered by making compost is entirely lost sight of.

Whatever the arguments are, one is forced to the conclusion that finance is the major consideration and that unless the venture can be proved to be a sound financial undertaking all the advantages attached to the adoption of such a process, from a sanitary, hygienic, anti-waste, or health point of view, seem to count for very little. Fortunately there are exceptions where urban authorities look upon the composting process as something that has come to stay whether the demand for the product remains what it is to-day or not. In this they find a substitute for a costly sewage scheme, for which they may never hope to raise enough funds. Many of them have already come to the conclusion that most of their disposal problems can be solved in a sanitary, hygienic, and profitable way by the adoption of the urban composting process, provided it is carried out under properly trained supervision.

6. Lack of interest. This was found to be due either to ignorance or wrong interpretation. In coastal towns and cities sanitary disposal problems are 'solved' by way of dumping the material recklessly into the sea. To a certain extent, however, an exception was found in the case of Durban, one of the biggest coastal centres. Here the Director of Parks and Gardens has set a worthy example to other similar centres by producing about 1,000 tons of compost annually from organic refuse on the true Indore principle, instead of allowing such materials to be passed through the city's incinerators.

The same lack of interest was encountered in large inland centres with properly equipped sewage disposal schemes. Their objections were in many instances well grounded as the adoption of a composting scheme would have meant the carting of raw materials over considerable distances to the site of the actual disposal works, thus making the scheme not only unpractical but also uneconomical. Fortunately in such centres compost is nevertheless made according to the true Indore method by Directors of Parks and Gardens, but usually on a scale only large enough for their own demands. The rest of the valuable refuse constituent usually finds its way to

incinerators where it disappears in smoke instead of being conserved and used on the land.

7. Fear of disease dissemination. In certain areas, especially the subtropical parts of Natal, local as well as medical authorities were afraid that amoebic dysentery might be spread by the use of the final product as a fertilizer. The Union Department of Public Health, however, expressed itself quite definitely on this point by issuing the following statement at the time: 'There is no likelihood of the matured compost, used as a fertilizer, acting as a medium for the dissemination of infective material of amoebic dysentery and parasitic worms, provided the process of composting has been carried out in accordance with the instructions issued by the Department of Agriculture and Forestry, where temperatures of 150° to 160° F. are attained in the pits for two to three weeks.' Although this statement, issued by responsible authorities, sounded convincing enough to most urban bodies, some diehards were nevertheless still encountered. The irony of it all is that some of these very same ardent objectors and critics will no doubt cheerfully buy and eat, without any objection or discrimination, vegetables raised by Indians in the sub-tropical parts on soils fertilized with crude and most probably amoebic dysentery-infested night soil.

Notwithstanding all these objections and difficulties, which naturally had a hampering effect on a more general adoption of the composting process, the results after two years from the inauguration of the scheme are spectacular and encouraging. From the table given it will be seen that before long this country may have at least 100 urban areas in which this process has been adopted. Although actually only about one-third of the urban centres in the Union are actively engaged in this work, the figures rather tend to give a wrong impression of the true position, since about two-thirds of the total urban population are included in the 100 centres mentioned.

Were it not for the instructional short courses held mainly at Ficksburg, Potchefstroom, Walmer, Fort Beaufort, and Graaff-Reinet, it is doubtful whether the actual position would have been as it is to-day. At these centres the various urban representatives became acquainted with the process in general very much more readily and thoroughly than would have been the case if they had had to be taught by their own experience.

Apart from the above, a very encouraging development has taken place at Darnall in the sugar belt of Natal, where Mr. G. C. Dymond has demonstrated so clearly that the vast quantities of sugar waste could be composted with little difficulty and at small expense to serve the essential purpose of linking up the productivity of soils of the sugar belt with the most important factor in the production of cane or any other crop, namely, yield. The same investigator hopes to prove that it may be possible to prevent the degeneration of varieties by practicing such conservation methods. For many years these mountains of valuable sugar waste were burnt or neglected, or their value as a compost manure overlooked, but now many scientists and planters in the sugar industry have become compost-minded. The author was invited to read a paper on this

subject at their recent conference held in Durban in April 1944.

Although the practice of burning trash before the cane is cut and transported to the mills may result in a saving of labour and expense, it is nevertheless an extremely wasteful procedure. The sooner some other and less wasteful method is discovered by means of which the plant could be stripped of its leaves in an economical and practical way, the better for the industry as a whole. By virtue of its high organic matter content cane trash is a very valuable fertilizer material when composted with nitrogenous substances. Even though the resultant manure may not be required on the plantation itself (which in itself is still a debatable question), together with megasse and filter press cake it may form a valuable by-product for any sugar concern if turned into compost and disposed of to fruit or vegetable farmers in the vicinity.

Compost is also manufactured at Durban on the Earpe-Thomas principle, mainly from vegetable leaves, fruit peels, leaves, and similar materials. It is claimed that according to this method the composting process can be completed within thirty-six hours by the inoculation of the material with special bacteria. The cost of production of this type of compost called, *Organo,* is very high in comparison with that of urban compost, but chemically there is very little difference between the two. A considerable quantity of otherwise wasted organic material is thus finding its way back to the soil, which otherwise would not have been the case.

In addition, some of the larger inland centres are making available considerable quantities of sewage sludge to market gardeners in their vicinity, while the effluent from sewage disposal works is often used for irrigating artificial pastures.

The above is a brief summary of the position as it presents itself to-day in this country. Very much more could undoubtedly still be done in utilizing the enormous quantities of valuable organic materials which are accumulating daily somewhere within the boundaries of urban areas.

As regards the return of the bulk of such materials to the land in the form of properly prepared compost, the question arises whether the State should not step in and either compel the local authority to make compost under supervision or itself undertake the composting of urban refuse material.

Before proceeding to a brief description of some of the experiments carried out at Ficksburg during the past two years in connection with urban compost, the author would like to give the chemical analysis of some samples, calculated on a dry basis, in the following table:

Origin of Sample	Percentage			
	Loss on Ignition	N	P_2O_5	K_2O

Ficksburg	34.43	1.14	1.42	1.24
Ficksburg	44.94	1.18	0.99	1.46
Ficksburg	39.17	1.12	1.41	1.39
Ficksburg	46.24	1.36	1.34	1.00
Ficksburg	47.61	1.53	1.92	1.08
Ficksburg	49.79	1.40	1.59	1.31
Walmer	44.37	1.54	2.76	1.10
Volksrust	30.21	0.78	1.49	1.11
Alberton	43.64	1.62	1.46	1.93
Bethlehem	42.30	1.58	0.90	1.19
Bethlehem	38.03	1.41	1.11	1.31

According to these figures and other observations made at Ficksburg, urban areas in the Union of South Africa are annually accumulating: 230 to 240 thousand tons of organic matter; 15.7 to 26.2 million pounds of nitrogen; 5.4 to 9.3 million pounds of potash; and 5.2 to 8.8 million pounds of phosphoric oxide, in the form of human excrete and town refuse. (The urban population is taken at about 3 3 millions for Europeans and non-Europeans.) Of these quantities, at least 50 per cent is lost or destroyed in one way or another with the result that, no matter how thorough the methods of salvaging and conservation, the quantity ultimately returned is only about half. The longer the return of this material to the land is delayed, the greater is the actual loss. The composting of urban refuse, therefore, is not only an essential but also a most urgent duty resting on the shoulders of those responsible.

As far as the process itself is concerned, in any composting scheme there is one dominating factor which must be borne in mind continually and that is temperature. This factor is not only an indication of the success with which the process is being carried out, but also determines the degree to which fly maggots and harmful pathogens may be destroyed. Temperature, therefore, may serve as one of the best indications of the success of a composting process. If it fails to develop, everything goes wrong: if, on the other hand, it develops favourably, we may take it for granted that the process is being carried out properly and successfully.

In the experiments carried out at Ficksburg since the inauguration of the national scheme temperature, therefore, played a major role. In view of the fact that harmful pathogens are destroyed at certain temperature levels if subjected to such temperatures for varying lengths of time, an experiment was carried out to determine average temperature ranges in an urban compost pit, the results being as follows:

Temperature Range in Degrees F.	Time Expressed as Percentage of Total (30 days) at which Compost Material was Subjected to such Temperature Range
51-60	1.78
61-70	1.11
71-80	2.89
81-90	2.00
91-100	1.77
101-110	2.22
111-120	2.67
121-130	9.55
131-140	24.67
141-150	33.33
151-160	18.00

It may at the same time be stated that this experiment was carried out during the winter months when the minimum temperatures were as low as 18° F.

If 125° F. could be regarded as the minimum safety limit (cysts of amoebic dysentery, for example, are destroyed at 122° F. in two minutes) then one may conclude that the material in a compost pit is exposed to temperatures above this limit for 80 per cent of the time and that the possibility is, therefore, exceedingly small of harmful pathogens surviving or being disseminated when subjected to such limits of heat over such long periods.

Temperature has also an important bearing on the extent to which flies will breed in a compost pit. Flies are not only a nuisance but a menace, since they are largely responsible for the spread of certain diseases and epidemics. After a careful study the conclusion was reached that, wherever excessive numbers of flies are encountered at a compost site, this may be taken as an indication that the process is not going properly, the most probable cause being carelessness. Experiments conducted at Ficksburg in this connection have proved that 85 per cent of the maggots present in the compost material during the process can be destroyed by giving the contents a thorough turning. The heat generated as a result of this will be sufficient to destroy them, provided the material containing such maggots is buried in the centre of the pit where, as a rule, the temperature is very much higher than at the bottom or along the sides. Naturally it is impossible to kill all the maggots in this way and some of them will ultimately escape as full-grown flies, but if poisoned bait is put out these may be got rid of as well. In the early stages of the process fly maggots fulfil a rather important duty, since they help to break up lumpy material, thus bringing about better

aeration and advancing the process in general. They should, however, be carefully watched and destroyed as soon as their job is done, otherwise they may complete their life cycle and cause endless trouble.

During periods of excessive rain one cannot rely on the above method alone, namely, that of killing maggots by working over the contents of pits, as the rain tends to cool down the material before the maggots are destroyed. An experiment was therefore conducted with certain chemicals harmless to the process but harmful to the maggots. Two relatively cheap by-products of the Iscor Steel Works were tried out. These were crude naphthalene and interstill residue. The former was used in a fifty-fifty mixture with sand, scattered over the surface of material and lightly worked in, while the latter, emulsified with soap water and used in a 4 per cent strength, was sprayed over the surface of the material in a pit. Both of these chemicals proved effective enough to destroy about 80 to 90 per cent of the maggots during excessively wet periods, when ordinary turning of the contents could not be resorted to. At the same time, these chemicals appeared to have no ill effects on the development of the process itself, judging by temperature observations during the experiment.

For the above two reasons alone it ought to be the aim of every compost producer to obtain as high temperatures as possible in the Compost pits under his supervision. There are certain external influences, however, over which one unfortunately has no control. Such factors are rain and atmospheric temperatures.

During the coldest months of the year a rainfall of 15 to 25 inches had the effect of decreasing the temperature in a compost pit by anything up to 15° F. On the other hand, a fall of less than 1-5 inches had no material effect on the temperature in a compost pit at all, and observations seemed to point to the fact that such precipitations may be expected to promote rather than hamper the process.

Minimum atmospheric temperatures of 16° F. to 18° F. during the winter months caused the temperature in a compost pit to drop only 2° F. This only seems to happen when temperatures fall to 20° F. or lower; above this, it was shown to have no material effect at all on compost temperatures.

Factors which influence the temperature in compost pits and over which definite control can be kept are depth of pit and quantity of night soil added per volume of dry refuse. Experiments proved that a four-foot depth of pit gave rise to about 30 per cent higher temperatures than did a two-foot pit, while a proportion of one gallon of night soil to one cubic foot of dry refuse gave the best results as far as temperatures were concerned. The wider the ratio of the latter, the slower the rise in temperature and naturally the longer the time before the process is completed.

Until such time as further tests are carried out, it may be stated that preliminary experiments seem to indicate that during the ripening process, over a period of six months, urban compost did not undergo any material change chemically, whether stored in the open or under protection. A reduction in volume may, however, have

taken place in the meantime.

Urban compost production in South Africa has undoubtedly come to stay. To most of the municipalities in the country who have adopted the process this way of refuse disposal means more than just a possible source of extra revenue or an answer to the call of the Department of Agriculture and Forestry to produce compost in order to relieve the fertilizer shortage in the country. To such centres it means, in the majority of instances, a solution to long-standing sanitary and other disposal problems that called for urgent attention long ago. It offers above all a hygienic, harmless, beneficial, and economic method of disposal of obnoxious collections accumulating in urban areas, where up to now these valuable, though dangerous, materials were merely lying scattered or buried on town commonages as a constant source of nuisance and possible disease infection. Furthermore, a proper composting process renders such materials harmless in a quick and efficient way, and may ultimately result in creating a healthier environment for congested communities.

Cities and towns have for too many centuries been veritable graveyards where, in most instances, only the charred remains of the youth and life of many a soil -- and ultimate civilization -- lie buried and forgotten. It is our duty, as well as our privilege, to ensure that such destructive, almost criminal, practices are no longer allowed to continue. It is sincerely hoped, therefore, that this brief description of what has been done along these lines in South Africa will serve the worthy purpose which Sir Albert Howard intended when he sent me his kind invitation to write this appendix.

If we are 'to endure, if we are to project our history, through four or five thousand years, as the Mongolian nations have done', according to the late Professor King in *Farmers of Forty Centuries,* 'we must re-orient ourselves; we must square our practices with a conservation of resources, which can make endurance possible'.

Ficksburg,
South Africa.
I9th December 1944.

"**Farming and Gardening for Health or Disease**" (The Soil and Health) by Sir Albert Howard, Faber and Faber, London, 1945, Devin-Adair 1947, Schocken 1972
Full text online at the Soil and Health Library:
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An Agricultural Testament

by Sir Albert Howard

Appendix C
The Manufacture of Humus from the Wastes of the Town and the Village

by Sir Albert Howard, C.I.E., M.A.
Formerly Director of the Institute of Plant Industry, Indore, Central India, and Agricultural Adviser to States in Central India and Rajputana.

Reprinted from a paper read at the Health Congress at the Royal Sanitary Institute held at Portsmouth from July 11th to 16th, 1938.

THE forest suggests the basic principle underlying the correct disposal of town and village wastes in the tropics. The residues of the trees and of the animal life, met with in all woodlands, become mixed on the floor of the forest, and are converted into humus through the agency of fungi and bacteria. The process is sanitary throughout and there is no nuisance of any kind. Nature's method of dealing with forest wastes is to convert them into an essential manure for the trees by means of continuous oxidation. The manufacture of humus from agricultural and urban wastes by the Indore Process depends on the same principle -- an adequate supply of oxygen throughout the conversion.

The Indore Process

The Indore Process, originally devised for the manufacture of humus from the waste products of agriculture, has provided a simple solution for the sanitary disposal of night soil and town wastes. The method is a composting process. All interested in tropical hygiene will find a detailed account of the big-chemical principles underlying the Indore Process, and of the practical working of the method, in the five papers cited at the end of this note.

Humus Manufacture at Tollygunge, Calcutta

Perhaps the best way of introducing the application of the Indore Process to town wastes will be to give an account of the recent work done by Mr. E. F. Watson, O.B.E., at the Tollygunge Municipality trenching ground, near Calcutta.

The conversion of house refuse and night soil into humus is carried out in brick-lined pits, 2 feet deep, the edges of which are protected by a brick kerb. The guard rim is made of two bricks laid flat in cement mortar, two quarter-inch rods in the join serving as reinforcement. The upper brick should project 1 inch over the pit to form a lip for preventing the escape of fly larvae. Each compartment of the pit has a capacity of 500 cubic feet and channels for aeration and drainage are made in the floor. The aeration channels are covered with bricks laid open-jointed, and are carried up at the ends into chimneys open to the wind. By this means air permeates the fermenting mass from below. At one point these channels are continued as a drain to the nearest low-lying land. It is an advantage when bricking the pits to give a slight slope towards the aeration channels as this helps in keeping the pits dry in wet weather. The area round the pit is protected by brick soling. Working details of these composting pits are shown in Fig. I.

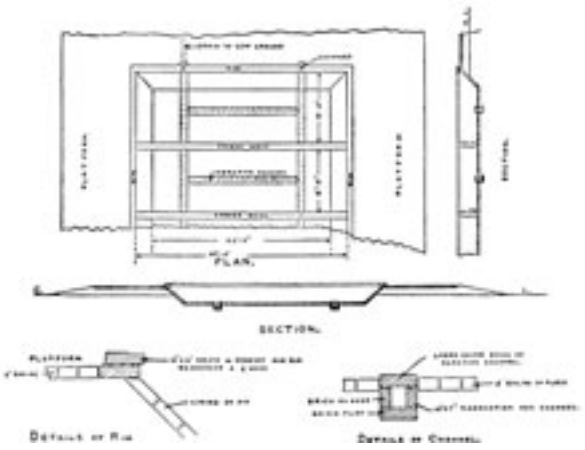

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FIG. 8. Plan and working details of composting pits at Tollygunge, Calcutta.

The method of charging the pits is most important, as success depends on correct procedure at this point. To begin with, a cartload of unsorted refuse is tipped into the pit from the charging platform and spread by drag rakes (Fig. 9) to make a layer 3 or 4 inches thick. Another cartload of refuse is then tipped on this layer and raked into a slope reaching from the edge to the middle of the pit and occupying its whole width. The surface of this slope is slightly hollowed by raking a little refuse from the centre to the sides. A little refuse is also raked on to the sill at the road edge to receive any night soil spilt on it by tipping. Half a cartload of night soil is then tipped on the slope and with the moistened refuse below it is drawn by drag-rakes in small lots until the breadth of the pit is covered. This done, the remaining half-load of night soil is poured on the freshly exposed surface of the slope and distribution by raking repeated until the slope (and the refuse on the sill) is altogether removed and forms a layer over

the whole of the pit being charged. Another cartload of refuse is then tipped, another slope made, the sill covered, night soil added and raked away. The whole group of operations is so repeated until the pit is charged. This takes 2 days. The top layer of the first day's charge must be covered with 2 inches of refuse and left unmixed with the layer below. This helps to keep uniform moisture and heat in the mixed charge and to prevent the access of flies. The last operation on the second day is to make a vacant space at the end of each pit for subsequent turning and also for assisting drainage after heavy rains. This is done by drawing up 2 feet of the contents at one end over the rest. The surface is then raked level and covered with a thin layer of dry house refuse.

There is no odour from a pit properly filled, because the copious aeration effectively suppresses all nuisance. Smell, therefore, can be made use of in the practical control of the work; if there is any nuisance the staff employed is not doing the charging properly. They are either leaving pockets of night soil or else definite layers of this material, both of which interfere with aeration and so produce smell.

First Turn. -- Five days from the start the contents of the pit must be turned. The object of this turn is to complete the mixing and to turn into the middle, and so destroy the fly larvae which have been forced to the cooler surfaces by the heat of the mass.

The original mixing of the heap, as well as the turning, are best done with long-handled manure drags by men standing on the division walls or on a rough plank spanning them.

Second Turn. After a further ten days the mass is turned a second time, by which time all trace of night soil will have disappeared.

Watering. In dry weather it may be necessary to sprinkle a little water on the refuse at each turn. The contents must be kept damp but not wet.

In very wet weather, when the surface of the pits is kept continually cool by rain, there is much development of fly larvae before the first turn, but since these cannot escape and are turned into the hot mass and destroyed before they can emerge as flies, no nuisance results. Flies, therefore, are most useful in providing another means of automatic control.

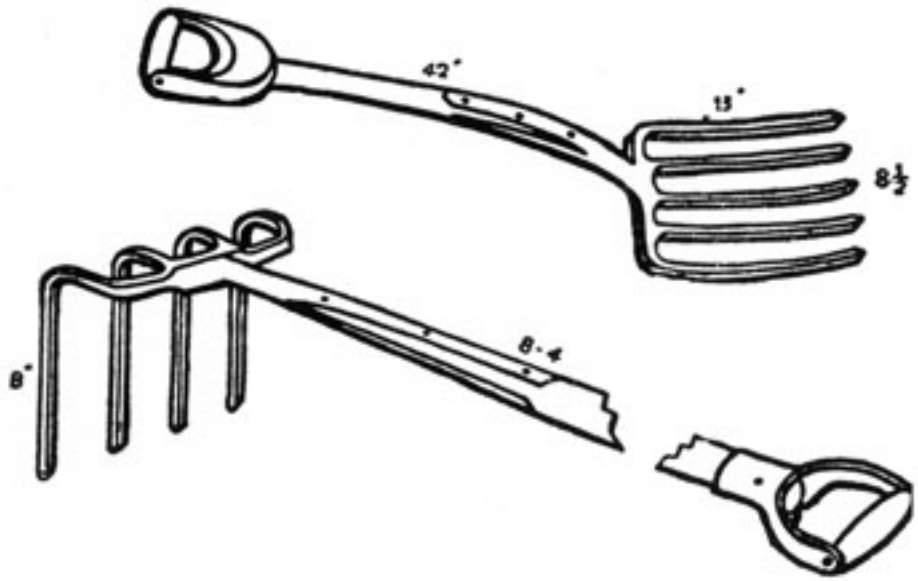

FIG. 9. Long-handled drag-rake and fork used in composting.

Ripening of the Compost. After a further two weeks the material is removed from the pits to the platform for ripening. The whole process, therefore, takes one month. The stacks of ripening compost should be 4 feet high, arranged clear of the loading platform on a stacking ground running between two lines of pits (Fig. 10). The stacking process permits of sorting. Any material not sufficiently broken down, such as sticks, leather, coco-nut husks, and tin cans are picked out and thrown into an adjacent pit for further treatment. Inert materials such as brickbats and potsherds are thrown on the roads for metalling. Hand-picking is easy at this stage, as the contents of the pit have been converted into a rough, inoffensive compost. The ripening process is completed in one month, when the humus can be used either for manuring vacant land or as a top dressing for growing crops.

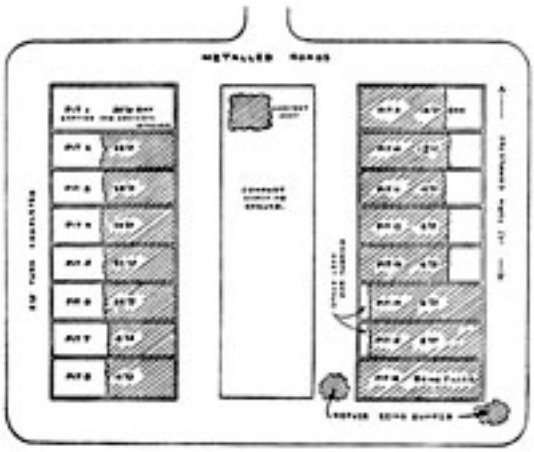

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FIG. 10. Plan of compost factory at Tollygunge, Calcutta, after one month's use.

Cost. The capital cost is very small. A population of 5,000 in India yields some 250 cubic feet of house refuse daily, enough to mix with all the night soil. This will require a compost factory of sixteen pits of 500 cubic feet each, one pit being filled in two days (Fig. 10). With roads, platforms, and tools this costs from Rs. 1,000 to Rs.

1,500. The daily output is 150 cubic feet of finished compost, which finds a ready sale at Rs. 5 to Rs. 7. At the lower figure the sale proceeds of the first year will be about Rs. 1,800. This more than covers the working expenses. A factory of this size will need a permanent staff of five men.

A Simple Installation for a Village

When a rural community is too poor to own conservancy carts or to construct brick-lined pits, composting can be carried out in an open trench on any high ground, without the use of partition walls.

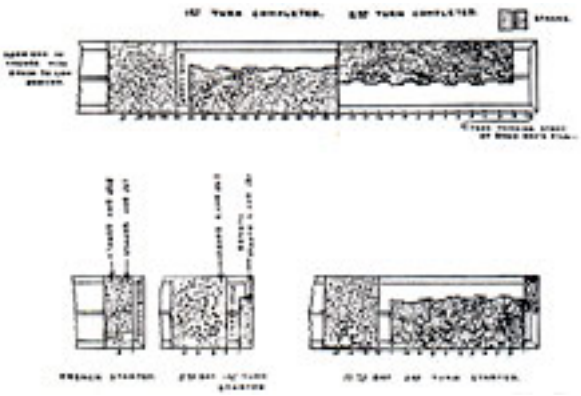

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FIG. 11. Plan of a simple composting trench for a village. First and second day's produce stacked and Section 2 ready for filling.

The difficulty with unlined pits is the escape of fly larvae which breed in the walls of the trench and in the stacks of ripening compost. This disadvantage can be overcome either by bricking the vertical walls or by keeping fowls, which thrive on the larvae.

Some Further Developments

The Use of Humus in Collecting Night Soil. There is one weak point in these two applications of the Indore Process to urban wastes. In both cases night soil is collected, transported, and composted in the crude state. This gives time for putrefaction to begin and for nuisance to develop. It can be prevented by the use of humus in the latrine pails, which ensures the oxidation of the night soil from the moment of deposition, and so prevents nuisance and the breeding of flies. The pails should contain at least 3 inches of dry humus when brought into use each day, and the droppings should be covered with a similar layer of humus when the pails are emptied into the conservancy carts. In this way putrefaction and smell will be avoided; the composting process will start in the pails themselves. The use of humus will augment the volume and weight of the night soil handled, but this increase in the work will be offset by the greater efficiency of composting, by the suppression of smell and flies, and by a considerable reduction in the loss of combined nitrogen.

Composting Night Soil and town Wastes in Small Pits. Night soil can be composted in small pits without the labour of turning. These pits can be of any convenient size,

such as 2 feet by 12 feet and 9 inches deep, and can be dug in lines (separated by a foot of undisturbed soil) in any area devoted to vegetables or crops. Into the floor of the pits a fork is driven deeply and worked from side to side to aerate the subsoil and to provide for drainage after heavy rain. The pits are then one- third filled with town or vegetable waste, or a mixture of both, and then covered with a thin layer of night soil and compost from the latrine pails. The pit is then nearly filled with more waste, after which the pit is topped up with a 3-inch layer of loose soil. The pit now becomes a small composting chamber, in which the wastes and night soil are rapidly converted into humus without any more attention. After three or four months the pits will be full of finished compost and alive with earthworms. A mixed crop of maize and some pulse like the pigeon pea *(Cajanus indicus)* can then be sown on the rows of pits as the rainfall permits, and gradually earthed up with the surplus soil. The maize will ripen first, leaving the land in pigeon pea. The next year the pits can be repeated in the vacant spaces between the lines of pulse. In two seasons soil fit for vegetables can be prepared.

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History of Plumbing in America

Baseball fans take note. Arizona's Hohokam Park in Mesa, Ariz., may ring a bell as the spring training grounds of the Chicago Cubs baseball team. It is named for the far-flung, extinct Hohokam Indians who played their own brand of ball and worked those same fields centuries before.

They were the master farmers of America's Southwest, and engineers of great networks of irrigation canals in the Salt River Valley. They first appeared about 350 B.C., building canals of open ditches, gouged out with stone tools and wooden hoes. The canals spanned almost 250 miles, stimulating trade and commerce between communities of hundreds and thousands of people. No one knows why, whether by climatic upheaval, drought or floods, the Hohokams suddenly vanished in 1450 A.D., well before Columbus discovered America or the Pilgrims landed at Plymouth Rock.

Left: American water pipes originally were made from bored-out logs like this artifact.

The Pueblo Grande ruins of this lost culture sit in ironic view of the jet planes taking off at the Phoenix airport. Located on East Washington Street, they provide a specter of dry bank canals 80 feet wide and 20 feet deep. Strange trash mounds offer clues of organic wastes, vegetation and shells.

And multi-storied "apartment" buildings attest to a condo style of life. But there is no evidence of any piping, latrines or privies. Native Americans, it is explained, have always shunned communal spots for defecation.

New World settlers would copy the Indians casual discharge of waste and refuse in running water, open fields, shrubs or forests. Like their folks back home in Europe, the colonials would also toss garbage and excrement out the front door and windows onto the streets below. The country's first garbage disposers would be hogs and scavengers.

It would be more than midway through the 19th century before young America would develop reasonably efficient water and sewage systems, and for the great invention of the water closet to make an appearance. But our forefathers made up nicely for lost time.
Thanks to the plumbing industry, the United States would set standards in health and safety unsurpassed m the world today. At the forefront was the unsung plumber, the skilled craftsman of lead, expert bell hanger, blacksmith, tool maker, tin and sheet-iron worker.

Closet Lore: Over 2,800 years ago, the fabled **King Minos** of Crete owned the world's first flushing water closet, complete with a wooden seat. Lost for centuries in the rubble of the palace ruins, the invention did not materialize again until 1594. Then, **Sir John Harington** built a "prive in perfection" for his godmother, Queen Elizabeth, to use in Richmond Palace, and one for himself at his humbler estate. Once he published his pompous book of terrible puns and off color jokes about the new device in 1596, *A New Discourse of a State Subject, Called the Metamorphosis of Ajax,* the ridicule and scorn would hound him for the rest of his days, and he never built another one. ("Ajax" was the slang in those days for a privy or "a jakes.") To the world's misfortune, another 200 years would pass before the idea took hold again.

Thus, when the colonists packed for the New World, they probably tucked a chamber pot in among other crockery items and tinware. But to a backwoodsman or a bride of 14, the term "chaise percee" or "commode" often disguised its use. In the early 1800s, a settler's wife reportedly bought several from the new stock at the local store for kitchen and table use.

The privy or outhouse slowly became accepted, albeit a peril for those walking by. One diarist disgustedly wrote: 'Privy houses set against ye Strete which spoiling people's apparill should they happen to be nare when ye filth comes out ... Especially in ye Night when people cannot see to shun them."

From the more humble and ramshackle outhouses of wood emanated more glorious structures. Human nature as it is, some became symbols of distinction as would current bathrooms of the well-to-do. **William Byrd's** 1730 outhouse was made of

brick and had five holes. Byrd was chef magistrate of the colonial court and thus sat on the largest seat at the center of a raised, semicircular bench. So did Mr. Byrd preside in the family privy.

Dozens of years later a two-story model was built and still stands in Crested Butte, Colo. The upper level was used when heavy snow blocked the first floor. A more typical, single-hole outhouse is found in a replica located in Old Sturbridge, Mass.

How to bring a workable water closet into the house without mess or odor was an invention waiting to be born, however. Some of the country's leading citizens would try to improvise on the basic knowledge of the times.

Thomas Jefferson, for example, devised an indoor privy at his Monticello home by rigging up a system of pulleys. Servants used the device to haul away chamber pots in his earth closet (a wooden box enclosing a pan of wood ashes below, and a seat with a hole cut out at the top). An architect and inventor as well as statesman, Jefferson also built two octagonal outhouses at his retreat at Poplar Forest in Virginia.

In the early 1840s, the architect and designers of New York City's Central Park denounced the outhouse as 'troublesome, unhealthy, indelicate, and ugly." It was all true. They tried to correct this by designing little Gothic structures combining a summer-house with a view of the garden on one side, and a two-holer on the other. Outside of a few private homes, hotels were the bastions of luxury and comfort - and indoor plumbing. In 1829, the brilliant young architect, 26-year-old **Isaiah Rogers**, sent ripples of awe throughout the country with his innovative Tremont Hotel in Boston. It was the first hotel to have indoor plumbing and became the prototype of a modern, first - class American hotel.

The four-story structure boasted eight water closets on the ground floor, located at the rear of the central court. The court was connected by glazed corridors to the bedroom wings, dining room and rotunda.

The bathrooms in the basement were fitted with cold running water which also went to the kitchen and laundry. The bathtubs were copper or tin and probably had a little side-arm gas furnace attached at one end. Perhaps shaped like a shoe as the French and English models, the water in the tub would flow and circulate backwards until the entire bath was heated to satisfaction.

Since the 1790s, the Northeast had bath houses, but not until this period several decades later would city hotels or new dwellings have baths as well. This simply was not feasible without a suitable water and waste supply system.

In the Tremont, water was drawn from a metal storage tank set on top of the roof, the recently-invented steam pump raising the water on high. A simple water carriage system removed the excretal water to the sewerage system. As with other individual buildings of the time, each had its own source of water and removal.

Five years later in New York City, Rogers surpassed his achievements of the

Tremont Hotel.

He built the Astor House with six stories, featuring 17 rooms on the upper floors with water closets and bathrooms to serve 300 guest rooms. The Astor and the Tremont were the first modem buildings built with extensive plumbing. (In contrast, the Statler Hotel in Buffalo caused a sensation in 1908 by offering 'A room with a bath for a dollar and a half.')

Rogers the architect was in very good company. His former employer was **Solomon Willard**, who had developed the first widely-used American system of central heating.

In the 1830s, at least one private house, a James River mansion, had a wood-fired hot air heating system. Heat wafted up to the first floor via handsome brass registers. Ladies of New York City's High Society wasted no time in flocking to the parlor after dinner to stand over its registers for warmth.

Central heating, however, was generally confined to the public rooms and hallways. Guest rooms were still heated during this period by parlor stoves and fireplaces. This lack of heat throughout the home retarded the development of bathrooms.

Our Dirty Forerunners: It was said that no house in Quincy, Mass., had a bathroom before 1820. When the temperature of a bedroom dips below the freezing point, there is no satisfaction in bathing.

Most Colonial bathing consisted of occasional dips in ponds or streams. Typical was a quote from Elizabeth Drinker, the wife of a highly-placed Philadelphia Quaker. She had a shower (probably a bucket arrangement) put up m her backyard for therapeutic use in 1799. She said, 'I bore it better than I expected, not having been wett all over at once, for 28 years past."

Left: A Copper lined closet, with oak high tank and seat.

When bathing did become the rage, it evolved over quack hygiene rather than cleanliness. Then there emerged a blend of latrine and spa just like in Merrie Old England.

In aping the customs of fashionable Britain, one historian commented that dueling probably killed fewer people than the spas springing up in various parts of the country. If the mineral waters tasted or smelled foul enough, people believed they could cure anything that ailed them. In the latter 1770s, Colonials would soak and sip in fashion as their counterparts at Bath or Spa, England, imitating the good society of the Old Country.

Warm Springs, Pa., in 1775 drew people from all over, taking in the waters. Some lived in cabins, all cooking at a common

fire. Gentile boarding houses and pumps were built, and dancing rooms added to the pleasantries. The adjacent mosquito-rich swamps were drained, and the church was enlarged to keep pious visitors happy.

A Dr. Benjamin Rush had the bad luck to have a well with horrible-tasting water in his back yard. The whole town flocked to it to cure all kinds of ailments. When the overpumped well went dry, the people learned too late that the well connected to the doctor's privy.

Many thought bathing was a health hazard. In 1835, the Common Council of Philadelphia almost banned wintertime bathing (the ordinance failed by two votes). Ten years later, Boston forbade bathing except on specific medical advice.

Poor water supply contributed to this attitude. The bathtub had to be filled and emptied with a hand pump and pail. It was too onerous a chore.

But by 1845, the installation of sanitary sewers began to pay off with an outlet for waste water, indoor plumbing and working water closets were getting closer to fruition. Unfortunately, bad plumbing and the stench from open sewer connections made some new homes uninhabitable.

Early in the 19th centery, the stack was vented through the roof, but no one knew how to property size the pipe. Usually the size was understated. Many vent pipes were so small they would clog up with frost during the winter. Not long after, a crown vent was added, i.e., the connection was made at the top of the vent.

In 1874, there was a tremendous breakthrough when an unknown plumber solved the problem of venting. He suggested balancing the air pressure in the system with the outside atmospheric pressure to prevent the siphonage or blowout of a water seal in the traps. He installed 1/2" pipe at the traps and extended the pipe outside. It worked for a little while, but then the vent clogged and the stench returned. Through trail and error, the plumbers learned to increase the size of the pipe.

Boring Business: Early settlers knew nothing of lead or iron pipe - they knew only to build with wood, the country's bounty.

Water pipes were made of bored-out logs, preferably felled from hemlock or elm trees. The trees would be cut into seven-to-nine-foot lengths, their trunks around 9-10" thick.

Wooden pipe laid below ground created several problems, however, especially in larger settlements or towns. Uneven ground below the joists would cause sags in the log where water would stagnate, infest with insects, and generally leave a woody taste.

The borers themselves were colorful characters who usually traveled in pairs from town to town bringing news and gossip of the area as they went about their job. With a five-foot steel auger between them, a handle at one end, they would fix the

log by eye, size it up with a point of the ax, and drill or bore out the center. Ramming one end to make a conical shape, they would jam the logs together in a series, using a bituminous-like pitch or tar to caulk the joists. Sometimes they would split the log and hollow it out, put it together, connect the logs with iron hoops, or get the blacksmith to caulk the logs with lead.

They would set up a gravity water system, starting from a spring or stream on high ground, allowing water to flow downhill to the house or farm. It would cut a path back of the house, through the barn, and flow into a catch basin.

In 1652, Boston incorporated the country's first waterworks, formed to provide water for firefighting and domestic use. As fire was a common hazard in those days of wood-framed houses and stores, and chimney fires always a risk, it was imperative that a ready supply be on hand.

The line supplying water to Boston's wharves and other buildings ran from Jamaica Pond to the Faneuil Hall area, the meeting place for the Massachusetts rebels who held their Boston Tea Party in the nearby harbor on Dec.16, 1773. Just recently a section of a wooden water main was removed from that same vicinity. The log measured 22 feet long, the bore a 4" I.D. for the lower half of the tree, and 2-1/2" in the upper. Common with early wood pipe, the tree's natural forks branched out in wyes and tees.

In 1795, the Jamaica Pond Aqueduct Corp. followed through with 15 miles more of 3" and 5" wooden water pipe of bored logs, again using hemlock trees for construction. Since open wells provided easy access to contamination from nearby privies, the new supply of fresh water contributed to a lower death rate.

Crude by almost anyone's standards, these new pipelines were nonetheless invaluable to firefighters. They would punch a hole into the wooden pipe along the edge of the street, insert a smaller pipe., presized to fit the newly borred hole and harness the hose of their fire wagon, a two man pumper. The fire out, they would plug up the hole again with a pre-cut conical stopper on the end of a long pole, insert it into the hole, and bang it shut. This was the " fireplug, " the wooden pole left sticking out of the ground marking the plug, ready to be pulled out for the next chimney fire.

Wooden pipes were common until the early 1800s when the increased pressure required to pump water into rapidly expanding streets began to split the pipes A change was made to iron.

Waterworks Come Of Age: In 81804, Philadelphia earned the distinction as the first city in the world to adopt cast iron pipe for its water mains. It was also the first city in America to build large scale waterworks as it drew upon the ample supply of the Schuykill River. A friendly neighbor, Philadelphia sold its cast- off wooden pipe to Burlington, N.J., where it remained in use until 1887, when larger mains were required.

Those were the days when the science of medicine in its infancy, and misguided

notions of causes of disease ruled the day. Philadelphia was motivated to clean up its city and draw upon a new supply of water in the mistaken belief that yellow fever was caused by the city's polluted wells rather than the bite of the mosquito. Yellow fever hit Philadelphia in 1793 with an impact like the Great Plagues of London.

Efficient waterworks depends on pumps. Prior to steam power in the 1800s, water wheels harnessed river flow to raise the water. On the frontier and on farms, windmills and simple hydraulic pumps provided the most efficient means of pumping water for the entire farmyard. A storage tank large enough to hold two or three days' supply of water would be mounted on the upper floor of the barn, water then piped to individual locations

By the latter 1800s, windmills would still be, in full force, their new and better workings keeping the farmers son from the lure of the big city. Who could resist this 1893 sale pitch from Aermotor Company

"Many a farmer's boy has been content to remain home through the great assistance rendered him by the Geared Aermotor. This tireless worker not only pumps water, but turns the grindstone, saws the wood, shells corn, chums, and a dozen other things that are most disagreeable to the boy, and that would tend to discourage him and make him discontented."

But metropolitan cities require more than windmills or simple hydraulic pumps to generate a water supply for an entire population, especially for those in the throes of the Industrial Revolution. The population of Chicago, for example, soared from 350 people in 1835 to over 60,000by mid-century. In 1869, the city unveiled a new engineering feat that made newspaper headlines around the world.

Left: An early 20th century outhouse with a fanciful design.

The Chicago Waterpower supplied the city with water via a twin-tunnel system which extended two miles out into Lake Michigan. Offshore, the clear take water entered an underwater shaft leading to the tunnel below the lake bed, the intake shaft protected by a wooden crib.

The first tunnel, completed in 1869, completed in 1869, contained a massive three foot-wide, 138, foot-tall standpipe which equalized pressure in the mains throughout the city's water system. The building was miraculously spared in the Great Chicago Fire of 1871, and still stands as a monument to the city's past.

Coal-fired, steam-driven engines drew water from the tunnel beneath the lake. They provided 15 million gallons per day into the city's water mains. When the pumping station was modernized in 1906 and new

engines installed, the standpipe was removed. The station today contains six powerful engines which pump 72.5 million gallons on an average day.

Sewers, PLEASE: Although Chicago is credited with having the first comprehensive sewerage project in the country (designed by **E. S. Chesbrough** in 1885), the already teeming city of New York provided the general model for the development of water supply and sewage disposal systems across the country.

Water was always at a premium in Manhattan, from day one of its purchase from the Indians in 1626. A bucket of water had to be hand-drawn and carried from springs or wells. Those too far away relied on peddlers who made rounds selling water by the bucket, off water carts or barrels. Later, water would be rationed at street pumps or hydrants which would operate frequently during the day.

Waste and garbage thrown onto the streets created abominable conditions, though people were merely following centuries old customs. hey were compounded by privy stations set against buildings whose "cleanup" presented even more problems. As early as 1700, concerned officials passed an ordinance prohibiting scavengers from dumping "tubs of filth" in the streets.

But driving wells and digging cisterns to collect water were still the primary means of procuring water throughout most settlements. However, water was not a popular beverage during those early days. A little girl from Barbados boarding with her grandmother in 1714 while the eight-year-old attended school in Boston, complained to her father that grandmother was making her drink water. Dad wrote back and insisted that she get beer or wine as befitting her station.

This distaste for water probably harkened back to the medieval notion that water caused the chills, plague and all sorts of ailments. The more likely reason was that the privy and the local well were too close together and spawned cholera and typhoid instead of good taste and purity.

In the early 1700s, New York, as did Boston, had constructed a wooden pipe system under the roads, and sold water at street pumps or hydrants. It would take New York another 25 years to lay underground sewers for storm water as well.

Another 50 years passed before New York constructed a truly viable public waterworks system. In this plan, well water was pumped to an above-ground reservoir and distributed via water mains of cast iron. The main carried the water to fire hydrants along the narrow streets. But five years later, the system broke down in the chaos of the great New York fire of 1835, which destroyed 530 buildings. The water supply could not cope with the demand of the firefighters.

In response to the needs of its firefighters and to provide potable water for the already teeming population, the city revamped its designs and developed a more sound, pressurized system.

Completed in 1842, the Croton Aqueduct System transported water from a huge reservoir in Croton, 40 miles north of the city, to a secondary reservoir on 42nd

Street, and to another in Central Park. They fed into a network of underground mains. Now it was possible to supply buildings with running water. However, except for a simple water carriage operation, there was no provision for waste water.

Engineer **Julius W. Adams** provided the framework upon which modem sewerage is based. In 1857, Adams was commissioned to sewer the city of Brooklyn, which then covered 20 square miles. There was no data available in proportioning sewers for the needs of the people. Yet, working from scratch, Adams developed guidelines and designs that made modem sanitary engineering possible. More importantly, he published the results. By the end of the century, how to textbooks would be available for towns and cities to use all across the country.

The pieces to the puzzle of good plumbing had finally come together proper venting, waterworks and sewers brought the closet indoors to stay. American potters duplicated the successes of their English predecessors, and then some. Finally, the mass production line brought down the cost of production of fixtures, fittings and valves, making them affordable and available from the rich on down. With the final correlation between disease and water borne bacteria the impetus to plumbing was complete.

The Closet Evolves: The development of the water closet in the United States parallels the experience of England where the modern closet was invented. But until the development of a one piece toilet with no metal parts, the closet would continue to be a source a contamination and a health hazard.

Like in England, the conical-shaped hopper was invented first. It set into a lead trap that was placed under the floor. Flushed by a valve directly connected to the bowl, it readily became a source of contamination.

Next came the pan closet, consisting of an upper earthenware basin and a shallow copper pan containing 3-5” of water as a seal at its base. It could be tipped to discharge the contents into a lower, large cast-iron receptacle connected to the drainage system. The metal pan operated on hinges, activated by a lever.

The washdown closet followed the principle of pan closets. The water was flushed by a direct line from a storage tank in the attic. Pull the handle in the closet, and it opened a valve at the top of the chamber. It was connected by a copper wire. The water flowed until the handle was released. It scored a complete flush as the water struck against a piece of sheet lead inside the bowl and caused a spray in all directions.

Unlike earlier models, a short hopper closet followed that was set on a tray, and the trap was placed above the floor. Originally made of stoneware, it was practically impervious. But later on, fireclay closets would be passed off to unwary customers.

The first American patent for a plunger closet is attributed to **William Campbell** and **James T. Henry** in 1857. It resembled the twin-basin water closets deplored by the great English engineer, **S.S. Hellyer**. The mechanism was unsanitary, as was the

trapless closet of **George Jennings**.

John Randall Mann, and American, developed a siphonic closet in 1870. Three pipes delivered water into the basin; one fed the flushing rim around the basin's edge, one discharged about a half gallon rapidly into the basin and started the siphonic action, and the third provided the after flush.

William Smith developed a jet siphon closet in 1876. It was carried still further by the famous American sanitary engineer **Col. George E. Waring, Jr.**, into larger and more complicated pieces of sanitaryware.

Thomas Kennedy, another American, patented a siphonic closet which required only two delivery pipes, one to flush the rim, the other to start the siphon. **William Howell** improved it in 1890, when he eliminated the lower trap without detriment to the action.

Ten years later, **Robert Frame** and **Charles Neff** of Newport R.I., produced the prototype of America's siphonic washdown closet, although it sometimes failed to develop the necessary action and the contents overflowed. Another decade passed before a redesigned bowl by **Fred Adee** would spur the production of the siphonic closet in America.

In the early 19th century, U.S. production of the closet was inferior to the English, and most closets were imported. By 1873, 43 British firms, including Twyford, Doulton, and Shanks were exporting high-quality closets to the U.S.

Left: A luxury bathroom of the 1890s would feature wood-encased fixtures in Victorian spendor.

By century's end, U.S. manufacturers caught up with the Europeans, and American products began to swamp this market. The American sanitary industry was said to have been born when pottery maker and decorator **Thomas Maddock** teamed up with his friend **William Leigh**. The timing was none to soon, because importing English materials was a very costly endeavor.

It was tough to convince fellow Americans to buy American products, however, so Maddock carefully stamped each closet with a lion and a unicorn, and the following inscription: "Best Stafford Earthenware made for the American market."

Harington had suggested a basin of brick, stone or lead dressed with pitch, resin or wax. Since then, stoneware, earthenware, fireclay and vitreous enameled porcelain led the way. Salt glazing was an early breakthrough; the process covered the materials with an impervious glaze which offered new resistance to stain and liquid.

Decorations were confined first to the bowl's interior because the wooden surround precluded any outside design-no one would see it. When the washout and the washdown models were now exposed in their entirety, the water closet became not only a functional product but an artistic one as well. The outside bowl could be embossed or colored for esthetic choice.

Pedestal models proved most popular, highlighted with elaborate patterns and fanciful names. Popular examples were the English Lion and the Dolphin models. The Dolphin curled up into letter S, the bowl in the shape of a fluted shell. (Carvings of dolphins had separated the seats used by the Roman soldiers in the privy at Timgad, an ancient Roman city in what is now Algeria.) A Dolphin water closet of Edward Johns & Co. won a Golden Award for design at the Great Philadelphia Exhibition in 1876. (The company today, Armitage Shanks, has reproduced the original "Dolphin Suite," complete with mahogany toilet seat, vanity doors and polished brass taps and fittings.)

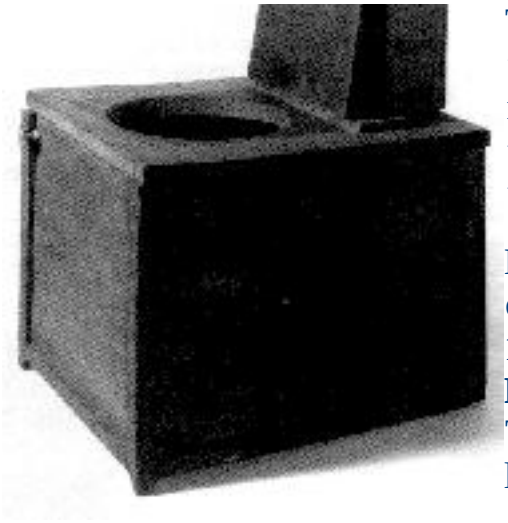
Underglaze patterns became popular, too, as well as hand-painted patterns of birds, flowers and fruit. Usually applied after the glazing, particularly with fireclay and similar materials, these underglaze decorations were less permanent. Gilding was the most expensive decoration: a specially-prepared gold, ground down with alloys and flux, compounded with turpentine and oil base, was applied by brush on an already embossed pattern.

Without extensive piping and adequate sewer and supply systems, however, the "modern" water closet would have gone the way of Harington's old relics. Early American plumbers, unschooled in the impressive engineering feats of their old Roman forerunners, would have to learn on their own how to build and construct comparable supply and waste systems. The method was still trial-and-error.

Bathrooms Come Of Age: For the well-to-do, an unused bedroom converted into the novel bathroom. The practice probably foreshadowed the trend of present-day "empty-nesters" to make unused bedrooms into fitness and relaxation centers. By the mid-1850s, however, finer new homes were being designed with separate bathrooms.

Benjamin Franklin is said to have imported the first bathtub to America. Brought over from France in the 18th century, this early creation was made of sheet copper shaped like a shoe, and hand-filled by bucket. A more common model would be in the shape of a mummy's tomb, all wood and six feet long.

Left: An earth closet used indoors used fresh earth or ashes on the bottom of the wood structure to absorb ordors.



The popularity of tub-bathing grew as the country flourished and expanded. For example, only 200 people resided in Tucson, Ariz., in 1865. By 1871, however, the town would boast 3,000 people, a newspaper, a brewery, two doctors, several saloons and one bathtub.

But the country's first bathtub with fittings-was commissioned by a Mr. Thompson of Cincinnati, Ohio, in 1842. He envied the invention of Britain's **Lord John Russell** and had the same tub duplicated for himself. The tub was encased in mahogany and lined with sheet lead. It measured 7'x 4', and weighed nearly one ton.

The fittings connected to two pipes running from the attic tank. One pipe carried cold water, the other was a hot water pipe that coiled down the chimney. The water heated as it passed through the coil.

Grander bathtubs a century later were encased in paneled or embossed wood. Big, brass fixtures were bold and showy in Victorian splendor. George Vanderbilt's bathroom of 1855 boasted a porcelain tub, and featured exposed pipe for all to see, the fittings reduced to a neat arrangement. Those with money tried to emulate Queen Victoria's bathroom where, it was said, the controls looked like those for a battleship.

The old Saturday night bath in front of the kitchen fire or potbellied stove was of tin or copper. Lead "gave way" to cast iron, which in turn was the forerunner of the modern enameled iron tub. Now we can add porcelain enameled iron and steel and acrylic, too.

By the turn of the century, a luxury bathroom would be a grand-sized room, outfitted with a 5-foot enameled tub, shower bath and receptor, sitz bath, foot bath, pedestal lavatory and siphon jet closet. Including all the fittings, trim and traps, the cost would come to $542.50. (Heavy tasseled drapes and stained glass windows were extra, of course. Although patterned wallpaper would yield to tile on the walls and the floor, the big area carpet would remain.)

When Johnny came marching home after the wars, builders could not keep up with the demand for housing. A land shortage in the throes of urban development sparked cubbyhole apartments and smaller homes than before. Tract housing would be one answer; downsizing the bathroom in sacrifice for more space was another tradeoff. Pedestal lavs disappeared as vanities with storage cabinets below topped the trend. Today, the reverse is true - bathrooms are bigger, the fixtures more imposing than ever. And at least two bathrooms are a must in most new houses.

Today, there are tubs for two and oversized tubs with accompanying oversized faucets, and lavs constructed from all materials including marble and precious stone. Where chrome and nickel plated faucets stood, luxury materials such as gold, malachite, tiger's eye, onyx and polished granite would take their place. In such a

setting, King Midas might well turn green with envy.

The growth of plumbing in America was phenomenal. In one 25-year period, from 1929 to 1954, sales by distributors of plumbing products and heating equipment rose from $498 million to $2.33 billion, a whopping 367% increase.

And manufacturers would cater to the increased demand with myriad choices of materials, colors and styles. Forerunners of great plumbing companies today would make their first appearances in the 1890s: Crane Co., National Tube Works (U.S. Steel), Ahrens & Ott and American Radiator (predecessor companies of American-Standard), and the Kohler Company, to name just a few. The single-handle mixing faucets so commonplace today are actually less than 50 years old. **Al Moen** is credited with the design for a double-valve faucet with a cam to control the two valves that he made in 1937. He refined the design into a cylinder with a piston action. Continued refinement has led to the replaceable cartridge, push-button diverter, back-to-back installation, swivel spray and pressure balancing valve.

Stainless steel is also a relative newcomer to the surging market of plumbing materials, perhaps exemplified by the growth of Elkay Mfg. Originally incorporated to manufacture pantry sinks of German silver and polished copper, Elkay added a line of d steel scullery sinks in 1921. By the 1950s, the company was spurring lines of sinks and faucets in stainless steel that would become mainstays of the plumbing industry.

Flexible water supplies are fairly recent developments as well. They were pioneered by **Robert M. Zell** the founder of Brass-Craft Mfg., back in 1939.

But today's manufacturers are not content to rest on past successes, as research and development produce better pipes, valves, fittings and fixtures. In the 19th century, plumbers used plain or tin lined lead piping for cold-water service, but they also had a choice of tin-lined, galvanized, enameled or rubber-coated wrought iron piping. Copper tubing was added after World War 1, and now plastic under certain conditions.

Left: This wooden box encloses a square water closet from early American days.

It seems that the wonders of the Ancient World and the Old Roman Empire have come full circle. Presently under construction is a grand hotel complex in Scottsdale, Arizona. It is patterned after the Hanging Gardens of Babylon. There will be 10 pools, 28 fountains, 47 waterfalls, a man-made sand beach and a Roman-style aqueduct. Under the watchful eye of the old Hohokam spirits, about 28 basic plumbing systems will be used to make this feat possible.

Of Codes And Men: It was only after the Civil War that the germ theory of disease was proven true, that contagion could be traced to contaminated water supply and unsanitary waste disposal. With waves of cholera, typhus and typhoid fever sweeping the country, the people turned to the resources of government to investigate the causes.

The English Pubic Health Code of 1848 became a model plumbing code for the world to follow. Twenty years later, the New York Metropolitan Board of Health was formed, the first such health board in the United States. Two years later, its Metropolitan Health Law was considered the most complete health legislation in the world. The nature of ground water was studied, as were drainage, sewage, water supply, waste disposal and location and characteristics of water closets. The plumber, long vilified in early years, saw his status upgraded to that of the Sanitarians

The idea of sanitary plumbing systems within buildings was an American development that soon spread throughout Europe. Over the next two decades and more, plumbing health codes expanded coverage to encompass examination, and licensing.

Trade associations were formed, spearheading plumbing ordinances and laws for regulations and examination. Master plumbers, while they had developed methods of trapping and venting to guard against contamination, had no real knowledge of hydraulic principles. So they installed systems they didn't understand or know how to design. Standards had to be proposed, and lessons in business management learned.

Appropriately, the National Association of PHCC (formerly the National Association of Master Plumbers), first met in committee in 1883 at the old Astor House, the hotel that provided the impetus to modern plumbing back in 1834. Many new plumbing inventions had appeared and too many plumbers were ill-prepared. Close on their heels would be the Mechanical Contractors Association of America, the American Society of Heating, Refrigerating and Air Conditioning Engineers, and the American Society of Sanitary Engineering.

Wholesalers banded together, too starting programs to prod manufacturers into standardizing such things as sink and basin outlets, faucet drilling, trap gauges, etc. The Central Supply Association, for example, was formed in 1894 and soon made contacts with the old Eastern Supply Association, the Plumbers Association of New England and the National Association of Master Plumbers. But it would take another 30 years to accomplish the standardization on which everybody takes for granted today.

An outbreak of amoebic dysentery in Chicago during the 1933 World's Fair was traced to faulty plumbing in two hotels. Tragic results were 98 deaths and 1,409 official cases. One year later, **Major Joel Connolly**, Chief Inspector of the Chicago Bureau of Sanitary Engineering, spoke these prophetic words:

"One of the lessons to be drawn from the amoebic dysentery outbreak ... is that plumbing demands the very best, painstaking effort that thoroughly qualified, certified plumbers can give in every building, and especially where the systems are complicated and extensive, and where large numbers of people may be affected by contamination of water."

from : Plumbing and Mechanical, July 1987

The reader wishing even more information on this topic is referred to *Plumbing and Mechanical* Magazine. This series of articles may NOT be reproduced in whole or in part without the written permission of Plumbing & Mechanical magazine. Contact them at pmmag.com

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to History of Plumbing Index

to International World Toilet History

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Urban Agriculture Notes

Published by City Farmer, Canada's Office of Urban Agriculture

Composting Toilets

(C) Copyright: City Farmer

Information on the use of composting toilets in cities is not easy to find. Building and plumbing codes don't encourage installation. Compost toilet systems are more common in parks, roadside facilities and vacation homes.

City Farmer has a Compost Toilet!

"But how do we use it", the staff wanted to know? "There's no water in the bowl, no handle for flushing. What can we throw in it, how do we keep track of how much human waste goes in, and what words should we use to describe our waste?"

The C.K. Choi Building
at The University of British Columbia

In Vancouver, British Columbia, a 30,000 sq. ft. office complex, utilizes composting toilets and urinals for human waste disposal. The new building, which houses The Institute of Asian Research, is not connected to the city's sewer system. As well, a subsurface, greywater recycling system with phragmite (tall grasses) plant varieties, cleanses the greywater which is then used for on-site irrigation.

The C K Choi Building at UBC is the first all-Clivus Multrum large-scale office-building project in Canada.

There are a total of 5 Clivus Multrum Model M28 Composters at the Choi Building...with ten flushless toilets and, in addition, several flushless, trapless ventilated urinals attached to them. Each of these Clivus Composters has an annually user capacity rated at 45,000 visits. Therefore, the total annual rated capacity for the Clivus systems there is 225,000 visits. All of the Choi building's washwater (greywater) is processed on-site separately.
For further particulars, inquiries can be directed to Laurence Scott, at the following email address:
clivusguys@comcast.net

Project Architects:
Matsuzaki Wright Architects Inc.
Suite 2410-1177 W. Hastings St.
Vancouver, B.C. V6E 2K3
Fax: (604) 685-3180

Design For the Next Millennium
The C.K. Choi Building for the Institute of Asian Research

Edited by Eleanor R. Laquian, 1996, 88 pgs.
Available at the Institute of Asian Research
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The Composting Toilet System Book: A Practical Guide to Choosing, Planning and Maintaining Composting Toilets, a Water-Saving, Pollution-Preventing Wastewater Alternative
by David Del Porto and Carol Steinfeld 1999
8.5" x 11", 240 pages, 300+ photos and illustrations, Black and white with color cover.
In this book, you will find

- Descriptions of more than 40 systems--both manufactured and site-built--and their sources
- Compatible toilet stools and micro-flush toilets
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Email: EcoP2@hotmail.com
Tel.: 978/369-9440
Price including shipping: US$ 33.25 (USA), US$ 43.95 (EUR 38.60) (International)

The Humanure Handbook A Guide To Composting Human Manure by Joseph Jenkins Award winning second edition, Published July, 1999,302 pages, 29 photos including color, over 100 tables and figures, indexed.

> "Written by a humanure composting practitioner and organic gardener with over 20 years experience, this second edition provides detailed scientific information on how humanure can be hygienically recycled, without fancy technological do-dads, a large bank account, toxic chemicals, or environmental pollution. This unique handbook provides

information on composting, soil fertility and microorganisms, alternative graywater systems and much more."

Colin Garland teamed up with Carol Steinfeld of the Center for Ecological Pollution Prevention (CEPP) to build
a composting toilet on Isla Coronado

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"Despite all of the knowledge humankind has accumulated in the past 10,000 years, we still do not know fully how to use our urine and manure to fertilize our farmlands in a way that is simple and efficient, will not spread disease, and will benefit the soil. This knowledge is increasingly important as soils continue to lose the minerals and organic matter they need to remain fertile. Discovering how to utilize our waste as fertilizer is the challenge we must meet if our farmlands are to continue to provide us with food."

The Toilet Papers: Recycling Waste and Conserving Water
By Sim Van der Ryn
The Toilet Papers, originally published in the 1970's, provides an informative, inspiring, and irreverent look at how people have dealt with human wastes over the centuries. He also discusses the history and philosophy of turning organic wastes into a rich humus, linking us to the fertility of the soil and ensuring our ultimate well-being.

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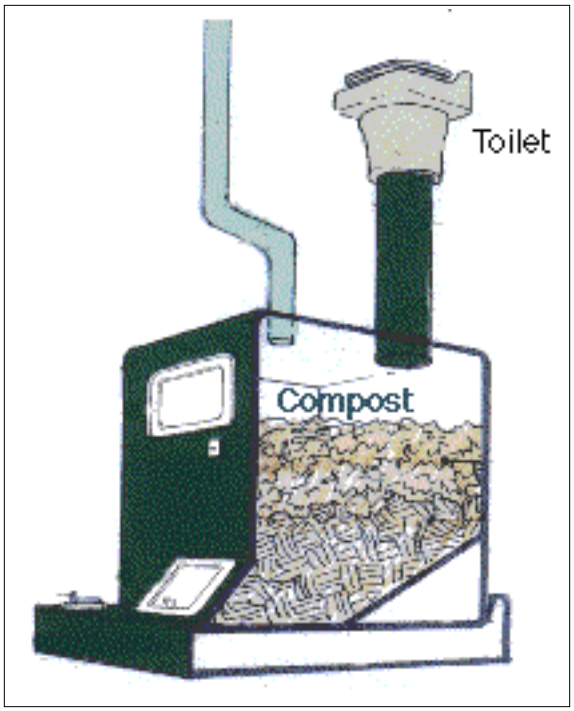
Appalachian Trail Conference/Green Mountain Club Backcountry Sanitation Manual

Pete Antos-Ketcham and Richard Andrews authored and edited the Appalachian Trail Conference/Green Mountain Club Backcountry Sanitation Manual in 2001. It is an online PDF manual that features information on several owner-built and commercially made composting toilet systems that are being used to manage human waste at high use campsites on the Long Trail and Appalachian Trail. This manual and the systems would be of interest to those who want to manage sewage in the frontcountry or the backcountry.

Manufacturers



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"The Clivus company in North American now manufactures roughly 90% of its composters in Canada: in Winkler and Winnipeg, MB, to be specific. The Clivus Multrum first came to Canada in the late sixties. There are residential and public facility Clivus systems in operation in all the provinces and territories-- some of the public facilities (such as those operated by Tourism Nova Scotia at the Government Washroom at Peggy's Cove) being visited annually by several hundred thousand visitors. The Peggy's Cover facility is Canada's first totally recycling, fully "green" public washroom configuration: It includes a splendid Clivus Multrum-designed grey water purification vegetable garden whose yields deeply impress visitors to the site. There's a magnificent greywater-purifying, Clivus-engineered grewyater-fed ornamental garden at the Irving Bouctouche Dune Eco-Centre....along with nothing but Clivus composters through the entire complex there. The compost tea generated by the two Model M28 Clivus composters and the M54 Clivus "Trailhead" stand-alone systems all gets recycled on tree seedling plantations nearby which the Irving Corporation manages."

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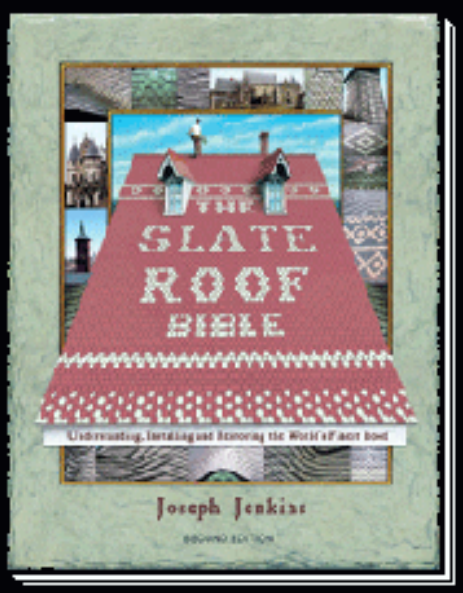

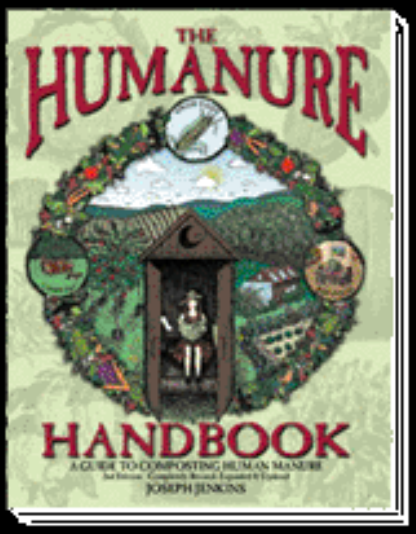

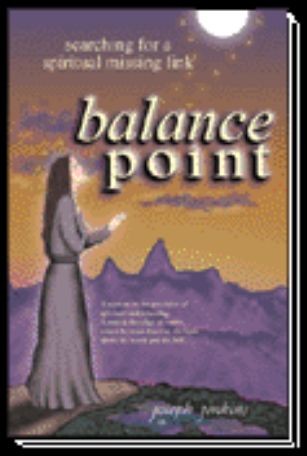

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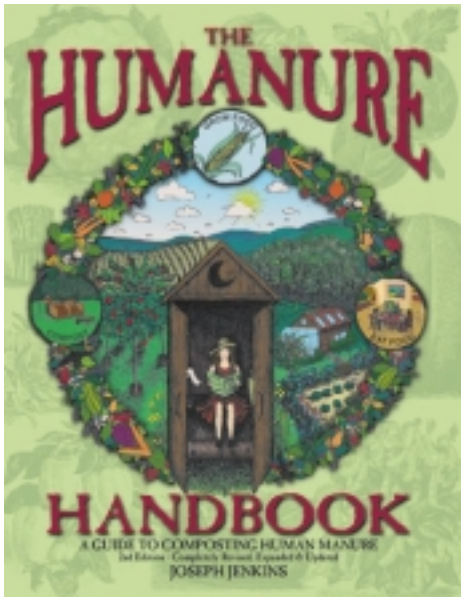

A Guide to Composting Human Manure

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Join a discussion with your fellow humanure composters!

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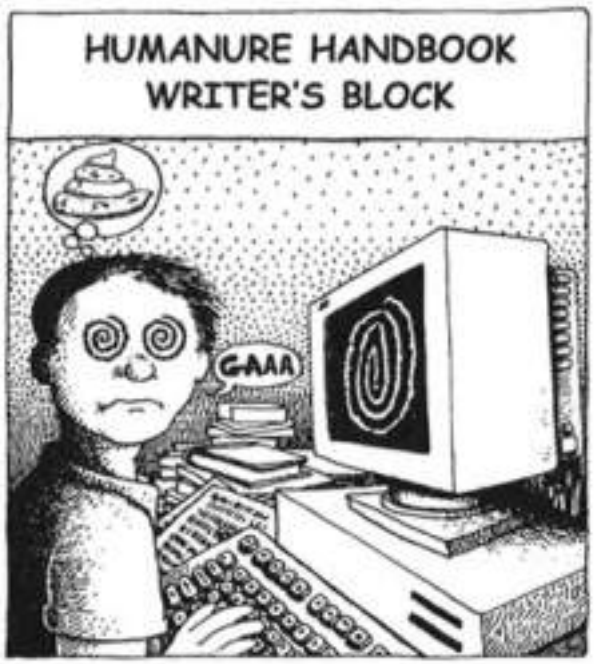


How to make and use a simple "sawdust" toilet

My version of a "sawdust toilet" (as described in the *Humanure Handbook*) consists of a receptacle bucket, a removable toilet seat that slips into the top, and a bucket of sawdust for covering after each use. When the toilet is full the seat is switched to the empty sawdust bucket. The toilet is emptied, cleaned and sanitized and then becomes the sawdust bucket after filling with clean sawdust. The whole toilet system, including outdoor compost chamber, can be constructed for less than $10. This simple, inexpensive, and hygienic toilet -- affordable to construct and maintain by just about anyone on the planet -- is a perfect example of an appropriate and sustainable technology.

Materials: three or more plastic 5-gallon buckets, one toilet seat, 6 wood screws, and 3 small pieces of wood that function as cleats (approximately, 1 inch wide by 3 inches long by 3/4 inch deep). You will also need a compost chamber; mine is constructed from recycled wooden pallets held together by wire at the corners (see photo 5).

Tools needed: wood saw, screw driver

Steps:

1. Using a wood saw, cut the top 4 to 6 inches off one of the buckets. This will serve as a flange to which a toilet seat is attached, allowing it to slip inside a second bucket. (See photo at left.) The bottom part of the cut bucket can be recycled, for example as a planter.

2. Attach this flange to the bottom of a toilet seat using two screws at each of three wood cleats. One screw attaches the cleat to the toilet seat; the second attaches the bucket flange to the cleat. (See photo at right and the three drawings below.) The four small brown objects in the photo, the original toilet seat spacers, are removed and discarded. The completed receptacle with flanged seat in place on a receptacle bucket is shown at the top of this page.

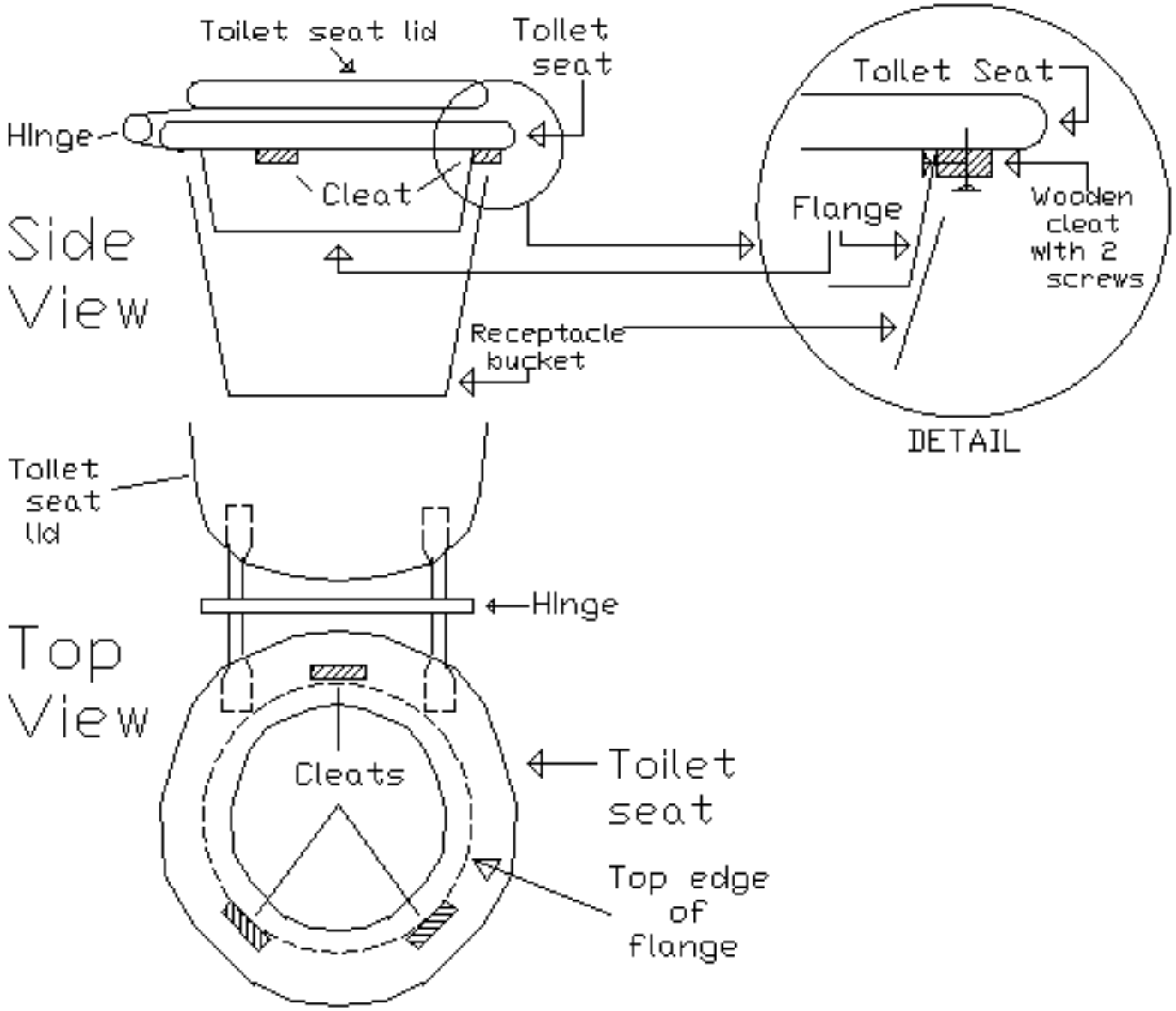
3. A second bucket contains sawdust, chipped wood, chopped straw, cereal hulls, or other absorbent carbon-rich organic matter. Covering with several cups or handfuls of this matter after each use effectively prevents odors. (See photo at right.)

4. When the receptacle bucket is full transfer the flanged toilet seat to the now empty sawdust bucket which then becomes the receptacle.

5. Empty the toilet contents into a composting chamber (left) and cover with a fresh layer of sawdust to prevent odors and present an aesthetic appearance. Clean the empty receptacle and sanitize and freshen in sunlight. This bucket, after filling with clean material, then becomes the sawdust bucket, and the cycle starts over. This step is the only time when odors are present, and only momentarily. Although not necessary, some individuals collect urine separately in a sealable container (such as an inexpensive but sturdy plastic bottle) because of its high value as a nitrogen source. It can be diluted by 5 parts water and put directly on plants.

This simple composting toilet system is inexpensive both in construction and to operate and, when properly maintained, aesthetic and hygienic. By closing the human nutrient cycle, it is a perfect compliment to organic gardening. In many ways it out-performs complicated systems costing hundreds of times as much! Although it may lack appeal in first world countries with their expensive, "out of sight, out of mind" sewage systems, it may be highly appropriate in areas that lack such complex infrastructure. However, there seems to be an explosion of interest in sustainability, and many more citizens are coming to feel that Composting Toilets are the Only Way to Go!

We recently tested a simple ventilation system to capture odors during use and vent them outdoors. This common-sense, basic capability is something lacking in almost all toilets, even in the wealthy industrialized countries. The American approach is to ventilate the toilet *room* by a fan installed in the ceiling. This makes some sense, as this approach will also ventilate a shower or bath. However, a much more effective approach, which *prevents* any odors from even escaping from the toilet, is to ventilate the toilet itself. You can achieve this by attaching a flexible air suction hose to the toilet flange powered by an electric fan which sucks air from the room and vents it either into the normal ventilation stack or through the wall to the outside. Our simple contraption consists of a second hand vacuum cleaner, a 2" check valve to prevent odors or outside air from flowing backwards into the room, a dimmer switch to lower the power (and therefore noise) of the vacuum, and a few pieces of 2" or 3" pipe to route the air flow. Total cost is less than $35 (vacuum: free, check valve: $17, other plumbing parts for routing air: about $5, dimmer switch and other electric parts: $10). The fan device is actuated for only a few seconds during use, until new deposits are covered when no further odors are present. This method works flawlessly and prevents *all* odors, *all the time*. For those who don't want to re-invent the wheel, I have come across a commercial version of a toilet ventilation fan, although I cannot vouch for whether it works well. Basically, it appears to be a thin device that fits between the usual toilet seat and the porcelain fixture. It ventilates air in its proximity with an electric fan. The following simple diagram shows the basic plan for this toilet (not including the ventilation device). The air suction device (connection by some type of flexible hose) attaches to anywhere on the flange.



Sawdust toilet / *Feedback welcome* / revised May 26, 2003

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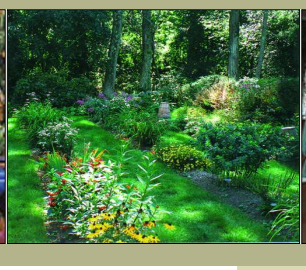

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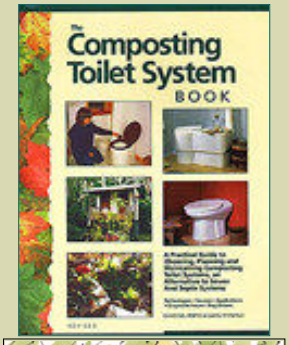

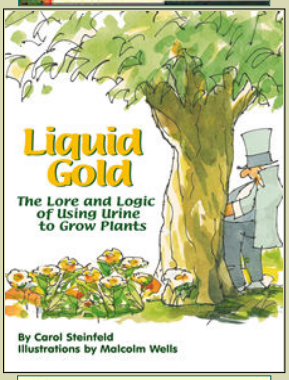

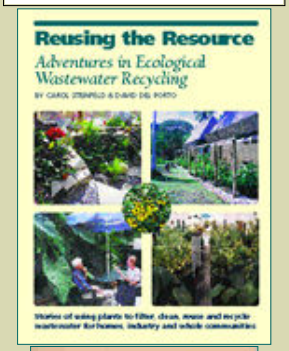

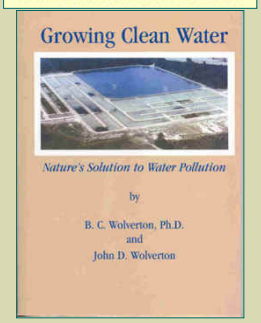

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Future Fertility: Transforming Human Waste Into Human Wealth
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The Complete Grow Biointensive Library

How To Grow More Vegetables,
Fruit, Nuts, Berries, Grains and Other Crops
Than You Ever Thought Possible on Less Land Than You Can Imagine

by John Jeavons
Perfectbound, 6th Edition, 2002, 280 pp., $17.95

Spiral Bound 6th Edition (paper) holds up better to heavy use.
Otherwise the same as the above. $19.95

A fully revised, updated and expanded edition of the book that helped revolutionize food production around the world (as well as in our backyard gardens) is now in a fully revised edition for the new millennium. Yes it is possible to grow fresh vegetables for a family of four on the front lawn! (i.e.., it is possible to grow all of this in 800 square feet of good biointensive beds).

The classic book on GROW BIOINTENSIVE[SM] gardening for beginners to advanced gardeners. The most complete and practical book of its kind, **proven effective in all sorts of garden conditions**. This book is every gardener's guidebook to healthier and more beautiful gardens. One book contains everything you need to know to grow the best crops.

This major revision updates everything, with the most current information, techniques and data, as well as adding such important, current topics as soil sustainability and the future of farming. All the charts and plans are updated, the bibliography is expanded by 25%. More information about how to work toward sustainble soil fertility is included. Best of all, an **index** has been added to make the book easier to use; something that lovers of this book have been requesting for many years. In use in over 107 countries in 5 languages.

Everyone who has used and enjoyed previous editions owes it to themselves and their gardens to have this book. The best thing any gardener can do for theirgarden!

> "...possibly the most detailed explanation of the Intensive gardening method available."-The New York Times

Foreign Language Editions

Cultivo Biointensivo de Alimentos..., Spanish
6th Edition, 2002, 261 pp, $10.00

How To Grow More Vegetables..., Arabic
John Jeavons, 1997, 5th Ed., 300 pp., $20.00

Comment Faire Pousser Plus des Legumes...,French
(2nd ed.) 115 pp, $7.95

Mehr Gemuse Im Eigenen Garten...,German
(1st ed.), 82 pp, $ 14.00

Kak vyraschivat' bol'she ovoschei...., Russian
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The Russian translation was a collaborative effort between Carol Vesecky, over 40 translators, editors, and volunteers, several businesses, our Peace Corps, and Ecology Action to help make a biological/agricultural change in Russia. Over 20,000 copies are already distributed, and the response is positive. We offer an inexpensive way to get a copy anywhere in the former Soviet Union through the Biointensive for Russia organization, thus empowering whole villages with low-tech, proven organic methods.

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(1sted),'87,70p.,$ 6

How To Grow More Vegetables..., Braille, 3rd Ed.
Write: Monterey County Braille Transcribers, Inc., BoxDF, Pacific Grove, CA for details.

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Dig It!

John Jeavons Double-Digging Video
John Jeavons, 1997, 30 min., $ 19.95

This new video shows how to prepare your soil better and much more easily by following the techniques John Jeavons has developed while double digging all over the world for the last quarter of a century. Learn directly from the master.These techniques will improve your garden, and its soil, wherever you live. Have fun digging!

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Proceedings from the Soil, Food and People Conference
Hugh Roberts, editor, 2002, 180pp., $30.00

From a conference presented by Ecology Action and attended by Biointensive practitioners from all over the world. Attendees were inspired and energized by the sharing of work and experience. If you missed this conference held at UC-Davis in March 2000, or attended and want to review the information, you'll love this book! Every speaker has been included, and there are photos and supporting material also. Some topics covered are: GROW BIOINTENSIVE™ Mini-Farming, farming with a passive solar greenhouse, heirloom seed preservation, reports from projects worldwide and much more. Relevant for everyone who enjoys using Biointensive techniques, but especially so for those who intend to teach these methods or work with them in other countries.

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The Sustainable Vegetable Garden:
The Backyard Guide To Higher Yields and Healthy Soil
by John Jeavons & Carol Cox, revised 1999, 128pp., $11.95

Formerly titled Lazy Bed Gardening, this book has been revised to include the latest information on "Grow Biointensive" techniques. Includes a new chapter on seed saving.

The Irish use this term for gardens that keep producing with very little work (relative to the high yields produced). With a little help from this book anyone can have lazy beds.

"A lazy bed is a deeply prepared bed (2' deep) whose growing area can produce up to four times more than an equivalent area prepared less deeply and planted in rows. So the gardener has only one bed to dig, one bed to fertilize, one bed to water, one bed to weed - only one-quarter the area it would take to produce the same amount of yield by other methods."

This book combines our experiences from How To Grow More Vegetables... and Booklets #14 and #26 into a new understanding of how to grow all your own food in the backyard, while also caring for the

health of your soil in a sustainable way.

The emphasis is on food gardening and improving the soil through crop selection. New gardeners can now benefit from direct garden research in at least 110 countries - this method has been tried everywhere, on every type of soil, in all climates, and it works for epicurean gardeners as well as third world farmers. It gives specific recommendations on the best crops for beginning gardeners, and how much to grow for a family's needs.

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One Circle,
How to Grow a Complete Diet
in Less Than 1000 Square Feet
Dave Duhon & Cindy Gebhard 1984, 200 pages,
Perfectbound paperback $16.95
Spiralbound paperback - holds up better to heavy use. $18.95

Using the techniques described in How To Grow More Vegetables..., this book will help you explore your nutritional needs and then design and produce a complete vegetarian diet in as little as 700 square feet. Loaded with charts, annotated bibliographies, step-by-step instructions, and even cut-out slide rules for the calculations. You're invited to participate in this bold, new cutting-edge of Biointensive development and research. You will need to read How To Grow ... first.

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The Backyard Homestead, Mini-Farm & Garden Log Book
Jeavons, Griffin, and Leler, l983, 234 pages, $19.95
Spiral Bound only

For those who want to develop more self-reliance, are considering earning an income from mini-farming, or just want to learn how to become more effective food growers. This companion book to How To Grow More Vegetables is the result of ten years of practical garden research and covers such subjects as food from your backyard homestead, beginning to mini-farm, tools you can make (including the **U-Bar**), plans to build portable greenhouses, crop profiles and tests, calendars, essential bookkeeping, and much more.

"...in his mini-green revolution John Jeavons is demonstrating that small is beautiful."-The Manchester Guardian

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Future Fertility:
Transforming Human Waste Into Human Wealth
John Beeby, 1995, 164 pp., $19.00

Returning the nutrients in human waste back to the soil from which they came is essential for the sustainability of agriculture worldwide. This detailed and practical manual describes several established and innovative low-technology methods of safely and effectively recycling the nutrients in human waste. More importantly, it describes the principles behind the methods , and criteria that any method must meet in order to ensure human waste is processed safely , and that the fertility of the soil is maintained sustainably. A must for those interested in transforming their waste into wealth in the future.

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The Basic Biointensive Library
19 books, $ 120.00

While How To Grow is all you need to start and to practice Biointensive gardening, we continue to produce additional materials of special interest. This collection of books provides a well-rounded education in Biointensive gardening for the advanced gardener or the professional . The basic books are: HTGMV, BYH, The Sustainable Vegetable Garden, One Circle, Booklets: 0, 1, 10, 12, 13, 14, 17, 18, 19, 20, 21, 22, 23, 24, & 26.

The Complete Grow Biointensive Library
all books, booklets and information sheets, $ 280.00

Everything Ecology Action has in print in English language as of Jan, 2003: books, booklets, information sheets, including *Man of The Trees* and *The Lavender Wand*. (Information about training programs not included.)

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COMPOST TOILETS

Many types of compost toilets are available today. They are designed to suit a variety of customs, cultures and climates, and vary enormously in price. Composting of human faeces is as old as the hills - it is Nature's way of safely reintegrating human waste with the soil. All compost toilets, however simple or complex, are devices for helping Nature achieve this. Contrary to popular opinion compost toilets can be very clean and hygienic and do not smell. They save huge quantities of water in a world where water is becoming an increasingly precious resource. For example, a family with a water flush toilet would use at least 100,000 litres of water a year for flushing. They protect surface and ground water from sewage pollution and, unlike water flush toilets, compost toilets do not produce sewage and do not smell.

This technical brief describes a compost toilet that has proved to be most effective in water-logged areas where pit-latrines and septic tanks are inappropriate. It is a simple design that does not require electricity or great investment. Built using local materials, it is a self-contained unit that produces good compost and protects the soil and water from any contamination.

The selection of the most appropriate type and design of compost toilet will depend on many factors which include social and cultural norms, attitude to faeces, existing hygiene and sanitation practises, sources of drinking water, availability of organic residues, climate, soil types, patterns of habitation and local construction materials etc. Note that, in dry climates, desiccating or drying toilets may sometimes be more appropriate than composting toilets because the dry ambient air can be encouraged to flow through the faeces chamber removing any moisture, thus rendering the faeces dry and odourless.

It is important to realise that any compost toilet programme also requires an education programme to ensure that the principals of use and maintenance are clearly understood and accepted by the user group.

At the end of this brief there are references to information on other types of compost and desiccating toilets.

Introduction

In waterlogged and high water table areas, pit latrines and septic tanks can, and often do, contaminate well water with human faeces. This is a common occurrence in coastal areas with high population densities. In such places where open defecation on the sea shore and derelict land is the normal practise, many families want to have their own, or at least, a community latrine. In a crowded village, the wells and latrines would be forced to lie close together. If septic tanks, soakaways and pit latrines are used, the well water will inevitably become contaminated. Water contaminated with human faeces puts people at a high risk of cholera, dysentery, diarrhoea, jaundice, typhoid, polio and intestinal worms. A dry composting toilet protects water and soil and therefore helps protect the people in the community. Coupled with an effective hygiene awareness programme this can result in significant reductions in the occurrence of diseases.

Compost toilets are often built with two chambers for simplicity of construction and operation. The two chambers are used alternately; decomposition continuing in the full one until it is emptied just prior to the other one becoming full. Each chamber has its own opening for removal of mature, non-odorous compost. Some types of compost toilet batch the waste in movable receptacles on trolleys or turntables whilst others generate the compost slowly and continuously as the material progresses through the device. Some require electricity for small heating elements (in cold climates) or fans (to ensure a positive airflow through the system). Some compost toilets combine the urine and faeces whilst others separate them. The compost formed by the combination of urine and faeces is better but these toilets are more

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likely to smell if used carelessly and they require much greater quantities of carbonaceous residues like sawdust and straw. Many of the more complex types require dry access under the toilet via a basement or cellar room.

Appropriate use

The compost toilet described here was designed to be a highly effective solution to sanitation in high water table and waterlogged areas. However, it can be used as a reliable and low cost water conserving technology in many other areas as well. It can be built beside or as part of a house in rural, urban or peri-urban areas and can even be established inside a house or apartment. It has the potential to make a significant contribution to domestic water conservation in towns and cities as well as rural areas. Also, since there is no need to connect it to sewerage systems, there is no extra burden on often already overloaded services.

The compost toilet is suitable for use by a family, or it can be built in clusters for institutions, schools, hostels and so on. However, it is recommended that the use of compost toilets is managed within the community and that very good education and awareness raising is done before building begins. Open access community compost toilets are not recommended other than in well-educated and highly motivated communities.

Location

Any toilet would usually be located on the down-wind side of a dwelling and the same applies for compost toilets. However, when built and designed well with good education, the compost toilet does not give any bad odours and can be placed almost anywhere. It should be remembered that vent pipes only function effectively when there is a passage of air over the top of them so site selection should take account of this. Access for compost removal should be within the owners plot to prevent disputes later, especially important in very crowded communities. A significant advantage of compost toilets is that their location is not dependent on the location of sewers or gradients. They can be established in a confined space either within or beside a human dwelling, whether it is a thatched hut or high rise apartment block.

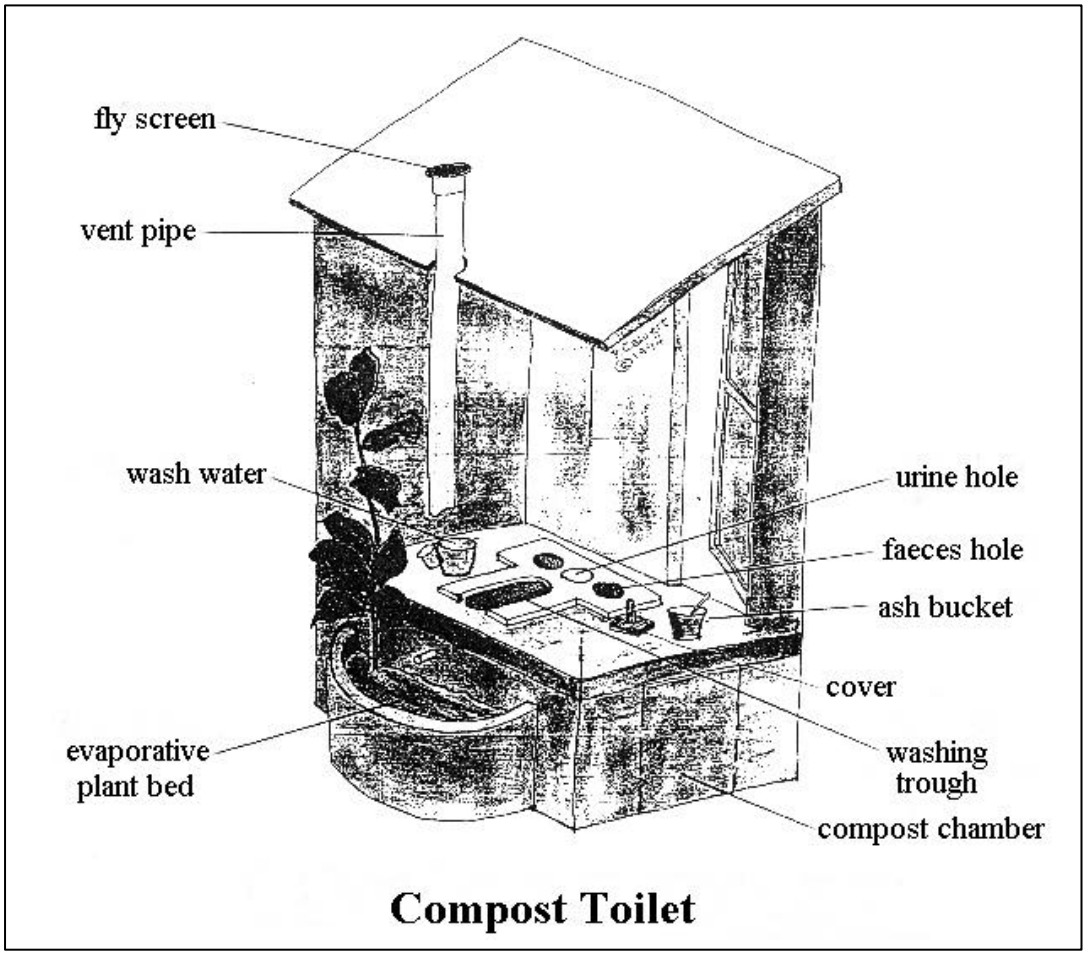
Construction

The compost toilet comprises a raised slab over two chambers. The chambers are built on the ground, not in it. In very waterlogged areas, or those prone to flooding, a slightly raised plinth can be made. The chambers are plastered with cement internally in order to waterproof them and make compost removal tidier. Over each chamber there is a hole in the slab for faeces and a funnel to receive the urine. In the centre of the slab, between the two chambers, is a trough over which the anal cleansing is performed. The anal cleansing water trough and urine funnel is inter-connected and flow to an evaporative plant bed outside the latrine.

In the simplest version, the chamber doors are closed by bricks and mud mortar, both of which can be reused to close it again. However, ferrocement, timber, marine ply or other materials may also be used where they are appropriate locally.

The chambers are designed to have an accumulation time of about nine months to allow thorough composting of the contents and elimination of pathogens. The compost produced is an almost dry, crumbly, black product having a light, pleasant, earthy odour. There is no fly nuisance or any odour problem and the toilets remain clean and pleasant to use. The plant bed needs almost no maintenance and the only requirement is to cut back excessive growth which can be chopped up and added to the compost chamber if required.

technical brief



© Paul Calvert

Operation and maintenance

Before starting to use the latrine, each chamber is half filled with straw, twigs or dry leaves. These provide the necessary additional carbon to the composting process and along with the faeces will compost down to a fraction of their original volume. Occasionally additional straw may be added through the faeces hole if the contents of the chamber start to become wet or slightly odorous. After each use, a spoonful of dry cooking ashes or lime should be sprinkled down the faeces hole which is then closed using a simple cover.

When one chamber is full its defecation hole is sealed and use of the second chamber begins. Once the second chamber is full the first is opened, the compost is removed and the chamber is re-primed with straw. The compost can be put around flowers, plants or trees. The urine and wash water go directly to the plant bed where flowering plants grow. The plant bed does not leak to the ground because it is sealed. Being diluted by the wash water, the urine does not smell and is quickly absorbed by the soil in the plant bed and feeds the plants. The plant bed area depends on local climate and the number of users.

Using the Compost Toilet

- Remove the cover.
- Squat and defecate in the defecation hole and urinate in the urine funnel. (A pedestal seat and urine catcher can be arranged if the culture favours sitting rather than squatting.)
- Wash over the washing trough.
- Instead of flushing, simply sprinkle a spoonful of dry cooking ashes, lime or sawdust into the defecating hole and replace the cover.
- Wash hands with soap and water.

technical brief

Awareness Raising

Adequate awareness raising and training needs to be given to the users in the early stages of establishing the compost toilet. It is essential that the toilet is correctly designed and built and that there has been a very interactive and participative approach to its introduction. If these steps are taken, there is a far greater chance of the compost toilet being "owned, understood and accepted" by the community which is essential if it is to be successful.

The need for interactive training and awareness raising is to unravel and dispel the misunderstandings and confusion that often surrounds sanitation, health, hygiene, water and the environment. For example, in one project the main interest in the compost toilet was for the privacy it gave rather than because it was safer and more hygienic than open defecation. At the same time, the greatest fear of the users and neighbours was that it would smell. By knowing the fears and misconceptions, the hygiene awareness raising can be tailored to suit the needs of a specific community.

Training of the awareness team must also be done very carefully and interactively as they may have the same misconceptions as the community. It is often beneficial to build the team from amongst women and youths already active in development in the community and who are held in good regard locally. Some methods that have been effective in reaching the community are the performance of street dramas explaining the many faecal-oral routes that give rise to disease and relating them to every day events and habits. Illustrated leaflets can be distributed, games played and songs sung with children and adults, both in school and leisure time. House visits should be made to follow up the messages and discuss the dramas and leaflets. These visits can be particularly effective since people are generally more willing to express any doubts in private.

Cost

The compost toilet described above is being built in India for around GBP£90 (1999) using fired bricks, cement mortar, a reinforced concrete slab and a ferrocement roof. It can be built for more or less depending on the complexity and permanence of the materials used and the level of refinement of the details sought by the owners. The roof, superstructure, internal finish and the door are the chief variables and can significantly affect the cost.

Benefits of Compost Toilets

The use of compost toilets means that cities and peri-urban areas do not need to extend capital intensive sewerage networks and sewage treatment plants. The recurring cost of maintaining additional infrastructure is also avoided. Both these factors represent a huge saving. Also, in areas where toilets would be flushed with municipal water there is an enormous saving in water requirements. Cross contamination between water mains and sewers is eradicated where compost toilets are well established as the standard sanitation technology. Soils are steadily improved by the regular addition of good quality compost. Conventional sewage treatment invariably leaves a dangerous sludge that still needs further treatment or incineration whereas compost toilet systems produce a useful product.

In water logged areas where there was previously no satisfactory sanitation system operating, the benefits that compost toilets provide are clear. They can prevent ground and surface water contamination and protect people's health in areas where open defecation on the ground or directly into water bodies has been the norm. The production of safe compost and effective use of the urine and wash water are also a significant benefit.

The technology also lends itself extremely well to areas with hard rocky soils where excavation of pits is difficult, expensive or inappropriate. Again the compost is valuable and can help to provide a better chance of establishing plant cover on thin and fragile soils.

technical brief

Summary - advantages of the compost toilet

- No need to dig pits.
- No need for sewers and treatment plants.
- No need for external infrastructure.
- Safe and affordable for anywhere but especially high water table and or water scarce areas.
- Does not pollute the ground or surface water or the soil.
- Does not produce flies or smell.
- Uses less water than any other toilet. A water flush toilet for a family can use 100,000 litres of water a year for flushing, the compost toilet saves all this water.
- Totally self-contained sewage treatment on site. There are no sewage pipes, no septic tanks, and no dangerous emptying of hazardous sludge.
- No mosquitoes. Septic tanks and pit latrines often have poorly fitting covers or the covers are not carefully replaced after emptying. These places then become prime breeding sites for mosquitoes. In a compost toilet there is no place for mosquitoes to breed.
- Produces safe, useful, non-odorous compost.
- The evaporative plant bed can support growth of attractive flowers, fuel wood, vegetable or plantain.

This technical brief by Paul Calvert is based on his experience of designing and building compost toilets and hygiene awareness programmes in India.

For further information please contact:

Useful addresses

Paul Calvert
"Pulari"
TC42/937(11)
Asan Nagar
Vallakadavu
Trivandrum - 695008
Kerala
India

Useful references

Fertile Waste: Managing your domestic sewage, Peter Harper, 1994,
Centre for Alternative Technology (CAT), Machynlleth, Powys, SY20 9AZ, United Kingdom.
Tel: +44 (0)1654 702400 Fax: +44 (0) 1654 703605. ISBN 1 89804 902 5 GBP£4.50

Lifting the Lid: Ecological approach to toilet systems,
Peter Harper with Louise Halestrap, CAT (address as above) ISBN 1 89804 979 3 GBP£10

Low-cost Sanitation; A survey of practical experience, J. Pickford, 1995, IT Publications,
103/105 Southampton Row, London, WC1 4HH, United Kingdom. ISBN 1 85339 233 2

Environmental Sanitation, S.A. Esrey, U. Winblad et. al. 1999 SIDA. Sweden.
Also available at the website www.gwpforum.org
Please visit www.compostingtoilet.org for more information.

technical brief

Appropriate Technology Transfer for Rural Areas

Farm-Scale Composting Resource List

Agronomy Resource List

ATTRA--National Sustainable Agriculture Information Service
PO Box 3657
Fayetteville, AR 72702
Phone: 1-800-346-9140 --- FAX: (479) 442-9842

By Steve Diver
NCAT Agriculture Specialist
December 1998

The PDF version of this document is available at
http://attra.ncat.org/attra-pub/PDF/farmcompost.pdf
9 pages — 196 kb

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Suggested Reading List for Farm-Scale Compost
Other Notable Compost References
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E-mail Discussion Lists & Web Forums
Bibliographies & Current Research on Compost

Suggested Reading List for Farm-Scale Composting

On-Farm Composting Handbook (NRAES-54), a Northeast Regional Agricultural Engineering Service publication, is a 186-page guide to on-farm composting. It provides a comprehensive summary of the composting process, composting methods, raw materials, using compost, site and environmental considerations, marketing, economics, and management. It is probably the best all-round publication on this topic published by the Extension Service. The cost is $20, plus shipping and handling.

Contact:

NRAES
Cooperative Extension
152 Riley-Robb Hall
Ithaca, NY 14853-5701
607-255-7654
607-254-8770
nraes@cornell.edu
http://www.nraes.org/

Compost for Manure Management is a special 77-page BioCycle report that focuses on turning livestock waste into a valuable soil amendment. Topics addressed include: Turning a Disposal Problem into a Profit Center; Making, Selling and Applying Composted Manure; Handling Liquids and Solids; Working with Traveling Composters; In-Vessell Systems and Anaerobic Digestion Technology; Getting the Right Materials Mix; Composting High Moisture Manure; Low-Cost Compost Pad Options. It lists for $39 (includes postage and handling) through:

BioCycle
419 State Ave.
Emmaus, PA 18049
610-967-4135
610-967-1345
biocycle@jgpress.com
http://www.jgpress.com/

B.C. Agricultural Composting Handbook, published by British Columbia Ministry of Agriculture, is a handbook consisting of eighteen composting fact sheets. It provides a nice complement to the NRAES publication mentioned above. Topics covered include: The Composting Process; Characteristics of On-Farm Composting Materials; Blending Materials for the Composting Process; Composting Methods; Site Selection; Co-Composting with Off-Farm Wastes; Economics; Using Compost; and others. Copies of the publication may be obtained for $10 Canadian (about $8 U.S.) through:

Resource Management Branch
B.C. Ministry of Agriculture and Food
1767 Angus Campbell Road,
Abbotsford, B.C.
V3G 2M3
604-556-3100
604-556-3099 Fax
http://www.agf.gov.bc.ca/

Woods End Agricultural Institute in Mt. Vernon, Maine, specializes in compost and soil analysis for organic farmers, consultation for compost operations, and research on compost. Dr. William Brinton, director of the laboratory, has published numerous

articles and publications on the composting process, compost analysis, and compost usage. Descriptions of the for-sale compost publications listed below are available on their website at <http://www.woodsend.org/>.

These publications are especially useful because they document practical efforts to compost farm wastes, food wastes, and food processing wastes.

- On-Farm Composting: Effects of Technology & Intensification on End-Product Quality and Costs
- Composting School Food Scraps
- Composting Potato Culls and Potato Waste Processing
- School Food Scap Composting
- Composting and Using By-Products from Blue Crab and Calico Scallop Processing Plants in Florida
- Composting Fish By-Products: A Feasibility Study
- Organic Growing Mix: Use of Compost in Potting Mixes
- Polycyclic Aromatic Hydrocarbons (PAH) in Paper Bedding
- Compostability, Health Risks and Bio-Degradation

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Other Notable Compost References

Science and Engineering of Composting: Design, Environmental, Microbiological and Utilization Aspects.

Proceedings of 1992 Composting Research Symposium, 728 pages. Edited by Harry Hoitink and Harold Keener of The Ohio State University. Major sections include: Microbiology, Systems and Infrastructure of Composting; Odor Control; Biodegradation of Organic Pollutants During Composting; Heavy Metals; Compost Stability and Maturity; Facility Management; Beneficial Effects Induced by Composts; Economic Considerations. Lists for $75 through JG Press/BioCycle, contact:

BioCycle
419 State Ave.
Emmaus, PA 18049
610-967-4135
610-967-1345
biocycle@jgpress.com
http://www.jgpress.com/

The Practical Handbook of Compost Engineering. 1993. By R. T. Haug. Lewis Publishers, Boca Raton, FL. 717 p.

This is a CRC Press-Lewis Publishers handbook edited by Roger Haug, adjunct professor at Loyola Marymount University. It provides a comprehensive review of composting with lots of engineering and technical specifications data. The sections on composting systems and compost biology are particularly useful. It is listed here mainly as a library reference book. It lists for $95 through:

CRC Press LLC
Customer Service
2000 NW Corporate Blvd
Boca Raton, FL 33431
561-994-0555
561-998-9114 Fax
http://www.crcpress.com/

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Associations

The Composting Council
4424 Montgomery Avenue
Suite 102
Bethesda, MD 20814
301-913-2885
301-913-9146 Fax
ComCouncil@aol.com
http://CompostingCouncil.org/

The Composting Council is an industry council that promotes industrial, commercial and home composting as an alternative solution to landfilling of organic wastes including biosolids, livestock wastes, food processing wastes, and paper wastes. It has commissioned a number of useful reports; a selection of publications are listed at its website below.

The Composting Council Publications
http://compostingcouncil.org/publications.cfm

- Farmer's Field Guide to Compost Production & Use
- Field Guide to Compost Use
- A Review of Composting Literature, 2nd Edition
- Guide to Commercial Food Composting
- Suggested Compost Parameters and Compost Use Guidelines
- Watershed Manager's Guide to Organics: The Soil and Water Connection

The Composting Council of Canada
16 Northumberland Street
Toronto, Ontario M6H 1P7
Canada
416-536-0240
416-536-9892 Fax
Email: ccc@compost.org
http://www.compost.org/

The Composting Council of Canada sells proceedings of composting conferences going back to 1992, as well as other publications and pamphlets.

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Web Resources on Farm-Scale and Large-Scale Composting

Cornell University Composting Home Page
http://www.cals.cornell.edu/dept/compost/

On-Farm Composting Handbook
http://www.cals.cornell.edu/dept/compost/OnFarmHandbook/coverpg.html

Agricultural Composting: A Feasibility Study for New York Farms
http://www.cals.cornell.edu/dept/compost/feas.study.html

MSW Composting Fact Sheets
http://www.cals.cornell.edu/dept/compost/MSW.FactSheets/msw.fs.toc.html

MSW Operator's Fact Sheets
http://www.cals.cornell.edu/dept/compost/Fact.sheets/Fact.sheet.TOC.html

Cornell Composting Resources and Publications
http://www.cals.cornell.edu/dept/compost/Compost_Resources.html

The Science and Engineering of Composting
http://www.cfe.cornell.edu/compost/science.html

Woods End Agricultural Institute on-line articles and publications:

Basis for Interpretation of Compost Analyses
http://www.woodsend.org/interp2.pdf

Bavarian On-Farm Composting
http://www.woodsend.org/ebersbe.pdf

The Dewar Self-Heating Procedure
http://www.woodsend.org/dewar.pdf

Sustainability of Modern Composting: Intensification Versus Costs and Quality
http://www.woodsend.org/sustain.pdf

Compost Use for Control of Powery Mildew (*Uncinula necator*)
http://www.woodsend.org/will2.pdf

Volatile Organic Acids in Compost
http://www.woodsend.org/voa-new2.pdf

Dynamic Chemical Processes in Biodynamic Horn-Manure Preparation
http://www.woodsend.org/bd_500.pdf

Living Compost - Living Carbon
http://www.woodsend.org/live-com.pdf

EPA Solid Waste Management: Composting Resources
http://www.epa.gov/epaoswer/non-hw/compost/

Innovative Uses of Compost: Disease Control For Plants and Animals
http://www.epa.gov/epaoswer/non-hw/compost/disease.txt
http://www.epa.gov/epaoswer/non-hw/compost/disease.pdf

Innovative Uses of Compost: Erosion Control, Turf Remediation, and Landscaping
http://www.epa.gov/epaoswer/non-hw/compost/erosion.txt
http://www.epa.gov/epaoswer/non-hw/compost/erosion.pdf

Innovative Uses of Compost: Reforestation, Wetlands Restoration, and Habitat Revitalization
http://www.epa.gov/epaoswer/non-hw/compost/reforest.txt
http://www.epa.gov/epaoswer/non-hw/compost/reforest.pdf

Analysis of Composting as an Environmental Remediation Technology
http://www.epa.gov/epaoswer/non-hw/compost/analysis.txt

Appropriate Technology Transfer for Rural Areas (ATTRA) publications

Notes on Compost Teas (ATTRA)
http://attra.ncat.org/attra-pub/compost-tea-notes.html

Worms for Composting (Vermicomposting) (ATTRA)
http://attra.ncat.org/attra-pub/vermicom.html

Sustainable Management of Soil-borne Plant Disease (ATTRA)
http://attra.ncat.org/attra-pub/soilborne.html

Organic Potting Mixes (ATTRA)
http://attra.ncat.org/attra-pub/potmix.html

Alternative Nematode Control (ATTRA)
http://attra.ncat.org/attra-pub/nematode.html

Sources for Organic Fertilizers and Amendments (ATTRA)
http://attra.ncat.org/attra-pub/orgfert.html

California Integrated Waste Management Board (CIWMB) Publications on Compost & Yard Waste
http://www.ciwmb.ca.gov/publications/default.asp?cat=2

Note: CIWMB publications are downloaded as MS-Word formatted publications

- Compost Demonstration Project on Use of Yard Trimmings Products: Agriculture in Partnership with San Jose, Pub#: 422-96-048
- Compost Demonstration Project, Fresno County: A Comparative Analysis of Soil Amendments Used in Peach Production, Pub#: 422-96-051
- Compost Demonstration Project, Monterey Bay Region: Demonstrating New Opportunities for Growers, Pub#: 422-96-050
- Compost Demonstration Project, Stanislaus County: Green Material Compost Use on Ornamental Nursery Plants and Field Crops, Pub#: 422-96-053
- Compost Demonstration Project, Tulare County: Green Material Compost in Field
- Crop Production, Pub#: 422-96-052
- Compost Field Experiment Guide for California Communities
- Compost Market Development: A Literature Review
- Compost Use on Cotton and Corn--Tulare County, Pub#: 421-98-005
- Compost Use on Peaches--Fresno County, Pub#: 421-98-006
- Compost Use on Vegetables and Nursery Plants--Stanislaus County, Pub#: 421-98-008
- Compost Use on Vegetables--Monterey Bay Region, Pub#: 421-98-007
- Composting Facilities, Pub#: 251-97-005
- Market Research into the Use of Organic Soil Amendments by Agriculture in California
- Northern California Compost Demonstrations, Pub#: 421-96-070
- Recycling Organic Materials on the Web, Pub#: 421-97-024
- Resource Conservation District Projects Using Mulch and Compost From Cities, Pub#: 422-97-043
- Results of Northern California Compost Demonstrations, Pub#: 422-97-029
- Southern California Mulch and Compost Demonstrations Expanded, Pub#:

422-97-042

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Other Notable Compost Web Links

Composting Animal Manures: Precautions and Processing
University of Hawaii, College of Tropical Agriculture & Human Resources
http://www.ctahr.hawaii.edu/publications/freepubs/pdf/AWM-1.pdf

In-Vessel Composting Research & Development and Rotating Tank In-Vessel Composting Demonstrations, Texas A&M University
http://www.TAMU-commerce.edu/coas/agscience/dept-res.html

Organic Composting for Horticultural Use
North Carolina Cooperative Extension Service
http://www2.ncsu.edu/bae/programs/extension/publicat/wqwm/ebae171_93.html

Composting Manure and Other Organic Residues
University of Nebraska Cooperative Extension Service
http://ianrwww.unl.edu/pubs/wastemgt/g1315.htm

Utilization of Organic Wastes: On-farm Composting
West Virginia University Extension Service
http://www.wvu.edu/~agexten/wastmang/utiliow.htm

A Cost Analysis of Municipal Yard Waste Composting
Department of Agricultural and Resource Economics, North Carolina State University
http://www.ces.ncsu.edu/resources/economics/compost/

Large Scale Utilization and Composting of Yard Waste
University of Florida Cooperative Extension Service
http://hammock.ifas.ufl.edu/pdffiles/he/he02700.pdf

D.M. Linton's Environmental Engineering Notebook: Compost Links
http://www.mgl.ca/~dlinton/current/compost.shtml

Effect of Windrow Composting on Weed Seed Germination and Viability
http://www.agric.gov.ab.ca/research/ari/matching/96-97/96m018.html

Internet Recycling and Composting Resource Page
http://www.recycle.cc/resource.htm

Low Cost Compost Screener
Producer Grant, Southern Region SARE
http://www.carolinafarmstewards.org/compostmixer/

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Compost Software

Compost Mixture Calculation Spreadsheets
http://www.cfe.cornell.edu/compost/download.html

The Cornell Compost Science & Engineering website has links for free downloads of Excel and Lotus spreadsheets. The spreadsheets have built in equations to solve compost mixture calculations for up to 4 ingredients. Spreadsheets are provided in Macintosh and DOS/Windows formats.

Compost Recip-ez® from Pike Agri-Lab Supplies
http://kiosk.maine.com/pals/

Compost Recip-ez® is a compost recipe software program from Pike Agri-Lab Supplies in Maine. It runs on the Excel for Windows spreadsheet and costs $250. The *Compost Recip-ez*® program assists in determining optimum C:N ratio, moisture level, structure ratings (porosity index), least cost blends, and associated compost management decisions. It also provides the option to enter compost variables, such as how much water needed to bring the compost windrow up to 50% moisture level in pounds or gallons or water. Contact:

Pike Agri-Lab Supplies
RR 2 Box 710
Strong, ME USA 04983
207-684- 5131
207-684-5133 Fax
Contact: Bob Pike
pike@somtel.com

FORCE3© V 2.0 — Composting Formulation Software
http://www.criq.qc.ca/english/so/pt/environment/force3/index.html

FORCE3 — Formulating Organic Recycling Compost Environment — is a Canadian software program for large-scale composters that easily and quickly calculates formulations with a user-friendly package designed for Windows®; simulates a variety of recipes from multi-waste products; evaluates the influence of each formulation ingredient on the composting process and the quality of compost to be produced. On the other hand it is rather expensive at $950 per unit. It is provided here as a reference, not a suggestion that expensive software is necessary for the average on-farm composter.

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Compost Magazines, Newsletters, and Journals

BioCycle
419 State Ave.
Emmaus, PA 18049
610-967-4135
610-967-1345
biocycle@jgpress.com
http://www.jgpress.com/
$69/12 issues a year

BioCycle is the leading trade magazine — published since 1960 — on farm, municipal, and industrial composting. Some of the nice features to BioCycle include: profiles and articles on compost operations and businesses, compost methods, compost uses, literature reviews, research reports, industry trends, economics and marketing, and equipment and supplies. *BioCycle* covers all aspects of the compost industry whether MSW, livestock manures, yard trimmings, woody materials, food residuals or biosolids.

Worm Digest.
P.O. Box 544
Eugene, OR 97440-0544
$12/year (4 issues)
mail@wormdigest.org
http://www.wormdigest.org/

Worm Digest is a quarterly newspaper that covers the use of worms in composting (vermicomposting) from small- to large-scale production, with world-wide coverage of vermicompost activities. Its goal is to network people, information and resources in the use of worms for organic waste conversion and soil enrichment. It is published by the Edible City Resource Center, a not-for-profit educational organization dedicated to the promotion of sustainable organic agriculture in urban and rural areas.

The Compost Connection for Western Agriculture
http://csanr.wsu.edu/programs/compost/

The Compost Connection for Western Agriculture is an on-line newsletter edited by David Granatstein with Washington State University's Center for Sustaining Agriculture and Natural Resources (CSANR). On-line issues date back to June 1996. *The Compost Connection* does a nice job of covering topics relating to farm-scale compost production, compost analysis, compost usage in agriculture, and compost resources.

Composting News
McEntee Media Corp
13727 Holland Road
Cleveland OH 44142
216-362-7979
216-362-6553 Fax
mcenteemedia@compuserve.com
http://www.recycle.cc/cnpage.htm
$83/12 issues per year

An industry newsletter that tracks current market prices for compost and related products. Also features: New composting legislation and regulation; New compost technology and patents issued; New compost research; New equipment and products.

Compost Science and Utilization
JG Press/BioCycle
419 State Ave.
Emmaus, PA 18049
610-967-4135
610-967-1345
biocycle@jgpress.com
http://www.jgpress.com/
$125/4 issues a year

Compost Science and Utilization is a quarterly peer-reviewed scientific journal focusing on management techniques to improve compost process control and product quality, with special emphasis on utilization of composted materials. This is a professional journal intended for researchers; managers; planners; consultants; municipal officials; and libraries. Topics covered include site management, problem prevention, compost quality, managing feedstocks, improving economics, public health, and compost value.

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Email Discussion Lists and Web Forums

Home Compost List

The stated purpose of the list is home composting. Indeed, Master Composters — trained by the Cooperative Extension Service — participate on a regular basis and provide helpful advice. Yet, Compost has become a prominent site for information exchange on all types of composting, including large-scale composting methods, resources, regulations, and technology.

To subscribe, send email to <listproc@listproc.wsu.edu>, and type SUBSCRIBE COMPOST YOUR NAME in the body of the message.

Post articles to: compost@listproc.wsu.edu

Archives available at <listproc@listproc.wsu.edu>, by sending INDEX COMPOST in the body of the message.

Wastenot List (WASTENOT: Organic Waste Collection, Processing, Composting)

Stated goals: WASTENOT is an unmoderated discussion and forum for the professional exchange of information and communication among those in the research of, management, design, implementation, processing, treatment, analysis, regulation, marketing and distribution, or usage of organic wastes and the compostable materials whether from industrial, commercial,municipal, or agricultural sources.

To subscribe, send email to <listserv@maelstrom.stjohns.edu>, and type

SUBSCRIBE WASTENOT YOUR NAME in the body of the message

Post articles to: wastenot@maelstrom.stjohns.edu

Archives available at <listserv@maelstrom.stjohns.edu>, by sending INDEX WASTENOT in the body of the message.

Large-Scale Composting Forum at OldGrowth Compost Resource Page
http://www.oldgrowth.org/compost/forum_large/index.html

Vermicompost Forum at OldGrowth Compost Resource Page
http://www.oldgrowth.org/compost/forum_vermi1/

Worm Forum at Worm Digest
http://www.wormdigest.org/cgi-bin/cgiwrap/zorba/forum.pl

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Bibliographies and Current Research on Compost

The Alternative Farming Systems Information Center (AFSIC) is one of several topic-oriented information centers at the National Agricultural Library (NAL).

AFSIC staff create and publish Quick Bibliographies (QBs), Special Reference Briefs (SRBs) and Agri-Topics (ATs). These publications focus on specific topics of current interest. QBs are bibliographic in nature, and are reflective of materials contained in the National Agricultural Library collection and/or indexed in NAL's database, AGRICOLA.

Quick Bibliographies on compost at AFSIC's website include:

Compost: Application and Use, QB 97-01 (June 1997) [390kb]
http://www.nal.usda.gov/afsic/AFSIC_pubs/qb9701.htm

Compost: On-farm Systems, QB 97-12 (September 1997) [275kb]
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Compost: Small-scale and Backyard Systems, QB 97-11 (September 1997) [105kb]
http://www.nal.usda.gov/afsic/AFSIC_pubs/qb9711.htm

The CRIS (Current Research Information System) database is USDA's computer-based documentation and reporting system for on-going agricultural, food and nutrition, and forestry research.

The CRIS database contains over 30,000 descriptions of current, publicly supported research projects of the USDA research agencies, agricultural experiment stations, and land-grant university systems. CRIS can be searched by keyword at the web address: http://cristel.nal.usda.gov:8080/

CRIS Theme Reports and Bibliographies is a series of pre-searched research topics that address current issues. The report titled *Composts: Soil Application and Effects* is one of the first eight Theme Reports and Bibliographies posted at: <http://ctr.uvm.edu/cris/theme/theme.htm>

Composts: Soil Application and Effects (6/28/96)
http://ctr.uvm.edu/cris/theme/com.htm

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By Steve Diver
NCAT Agriculture Specialist
December 1998

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On-Farm Composting Handbook

Description

186 pages $25.00 NRAES-54

ISBN 0-935817-19-0

***** This publication was awarded a blue ribbon in the 1993 ASAE Educational Aids Competition.***

This handbook presents a thorough overview of farm-scale composting and explains how to produce, use, and market compost. The information will be useful for farmers, waste producers, environmental regulators, and public health officials. Topics covered include benefits and drawbacks, the process, raw materials, methods, operations, management, site and environmental considerations, using compost, marketing, economics, and other options for waste management. Also included are 55 figures, 32 tables, calculations, references, and a glossary. (1992)

NRAES Publication List | NRAES Homepage

News Release

With increasing concern about the environment, composting has become an attractive option to turn problem materials and waste into a valuable product which can be returned to the land. A publication from the Northeast Regional Agricultural Engineering Service, **On-Farm Composting Handbook, NRAES-54**, presents a thorough overview of farm-scale composting and explains how to produce, use, and market compost.

The information is intended to help farmers decide whether composting or the use of compost is appropriate for their farm. For waste producers, environmental regulators, and public health officials, the handbook provides insight about agricultural composting and what it can reasonably accomplish. With this guide, those interested in a more effective means of waste management will

be better able to plan and implement a farm-scale composting operation.

The **On-Farm Composting Handbook** is 186 pages long, with 11 chapters, 6 appendixes, a glossary, a suggested readings section, and a references section. The text is supplemented by 55 figures and 32 tables, as well as calculation examples, work sheets, and informative sidebars.

The 11 chapters cover the following topics: benefits and drawbacks of composting, the composting process, raw materials, composting methods, composting operations, management, site and environmental considerations, using compost, marketing agricultural compost, farm composting economics, and other options for waste management and composting. The 6 appendixes present the following information: characteristics of raw materials, equipment tables and manufacturers, troubleshooting and management guide, work sheets and forms, lists of state environmental agencies, and metric conversions. The glossary contains 150 words, and over 160 publications are listed in the references and suggested readings sections.

This publication was edited by Robert Rynk, extension waste management engineer, Extension Agricultural Engineering, University of Idaho. The team of writers were Rynk; Maarten van de Kamp, compost program consultant, Massachusetts Department of Food and Agriculture; George B. Willson, owner, George B. Willson Associates; Mark E. Singley, professor emeritus, Biological and Agricultural Engineering, Rutgers University; Tom L. Richard, biological engineer, Agricultural and Biological Engineering, Cornell University; John J. Kolega, associate professor emeritus, Natural Resources Management and Engineering, University of Connecticut; Francis R. Gouin, professor, Horticulture, University of Maryland; Lucien Lalibery, Jr., managing director, Farm Resource Center; David Kay, research support specialist, Agricultural Economics, Cornell University; Dennis W. Murphy, extension broiler specialist, Poultry Science, University of Maryland L.E.S.R.E.C.; Harry A. J. Hoitink, professor, Plant Pathology, The Ohio State University; and William F. Brinton, president, Woods End Research Laboratory, Inc.

On-Farm Composting Handbook, NRAES-54, is available for $25.00 per copy (plus shipping and handling) from NRAES, Cooperative Extension, PO Box 4557, Ithaca, New York 14852-4557. Quantity discounts are available. The shipping and handling charge is $6.00 for a single copy within the continental United States. New York residents, add 8.25% sales tax (calculated on both the cost of publications and the shipping and handling charges. Click here for more information). If ordering more than one copy, or if ordering from outside the continental U.S., please contact NRAES for shipping costs. Orders from outside the United States must be prepaid in U.S. funds. Major credit cards are accepted, and checks should be made payable to NRAES. For information about quantity discounts, or for a free publications catalog, contact NRAES by phone at (607) 255-7654, by fax at (607) 254-8770, or by e-mail at nraes@cornell.edu. NRAES also maintains a Web site at http://www.nraes.org

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Related Links

- Cornell Composting Homepage

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Field Guide to On-Farm Composting

Description

128 pages $14.00 NRAES-114

ISBN 0-935817-39-5

This book was developed to assist in day-to-day compost system management. It is spiral bound, is printed on heavy paper, and has a laminated cover for durability. Chapter tabs make finding information a snap. Topics discussed in the book include: operations and equipment; raw materials and recipe making; process control and evaluation; site considerations, environmental management, and safety; composting livestock and poultry mortalities; and compost utilization on the farm. Highlights of the guide include an equipment identification table, diagrams showing windrow formation and shapes, examples and equations for recipe making and compost use estimation, a troubleshooting guide, and 24 full-color photos. This book is intended as a companion to the highly successful On-Farm Composting Handbook, NRAES-54. (1999)

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News Release

Composting continues to gain momentum as an environmentally sound way to stabilize and reduce the volume of agricultural and municipal wastes. A new publication from the Natural Resource, Agriculture, and Engineering Service (NRAES) is designed to help agricultural producers in the day-to-day management of an on-farm composting operation.

The Field Guide to On-Farm Composting ($14.00 plus S&H/sales tax, 128 pages, April 1999) is a handy reference guide that helps on-farm composters find practical information about composting quickly and easily. It answers common questions such as: What is the optimum

moisture content and bulk density of a compost mix? Why is my compost operation odorous and how can I control the odor? How long does it take to compost poultry mortality? How much compost can I land apply? The field guide was developed as a companion to the best-selling NRAES publication On-Farm Composting Handbook (NRAES-54) and is available from NRAES. It will be a valuable educational tool for cooperative extension educators and agricultural advisors.

The Field Guide to On-Farm Composting is intended to be used in the field. It is compact, spiral-bound, and printed on durable glossy paper with a laminated cover. Colored chapter tabs make finding a specific chapter a snap. The text is supplemented with 17 tables, 24 illustrations, commonly used equations, bulleted lists, and many sample calculations for at-a-glance referencing. Other highlights include 24 color photos and a case study written by technical staff of the U.S. Department of Agriculture Natural Resources Conservation Service (USDA-NRCS); the study discusses results of agricultural field trials using compost on highly erodible soils in the state of Texas.

The field guide contains six chapters. Chapter 1, "Operations and Equipment," reviews composting operations, from raw material preparation to compost storage, and discusses equipment needed for on-farm composting. Chapter 2, "Raw Materials and Recipe Making," presents descriptions and characteristics of the most common raw materials used for on-farm composting and includes easy-to-read tables and standard formulas for developing a successful recipe. Examples of recipe formulation are included. A special section reviews the basics of recipe making for first-time composters. Chapter 3, "Process Control and Evaluation," discusses steps for maintaining the necessary biological conditions in a compost pile and reviews sampling, testing, and troubleshooting procedures. A lengthy troubleshooting guide is included at the end of the chapter. Chapter 4, "Site Considerations, Environmental Management, and Safety," presents basic requirements for siting a farm composting operation, including area and buffer zone requirements; reviews common nuisances such as odors, pests, runoff, and leachate and outlines procedures for controlling them; and discusses important safety issues, including worker health. Chapter 5, "Composting Livestock and Poultry Mortalities," explains procedures for planning, constructing, and managing an animal-mortality composting operation. A discussion of pertinent environmental and regulatory issues is included. Chapter 6, "Compost Utilization on the Farm," examines important characteristics and benefits of farm compost and presents a brief overview of the most common uses of compost on the farm. Equations and tables for determining appropriate application rates are included as well.

The Field Guide to On-Farm Composting was edited by Mark Dougherty, former NRAES staff engineer. The project was made possible through a cooperative agreement between NRAES and the USDA-NRCS.

The Field Guide to On-Farm Composting, NRAES-114, is available for $14.00 per copy plus shipping and handling from NRAES, Cooperative Extension, PO Box 4557, Ithaca, New York 14852-4557. Shipping and handling for one copy is $4.25 within the continental United States. New York residents, add 8.25% sales tax (calculated on both the cost of publications and the shipping and handling charges. Click here for more information). If ordering more than one book or if ordering from outside the United States, contact NRAES for shipping rates and possible quantity discounts. Orders from outside the United States must be prepaid in U.S. funds. All major credit cards are accepted, and checks should be made payable to NRAES. For more information or

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the western region USDA-SARE Program

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v. intr.
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n.
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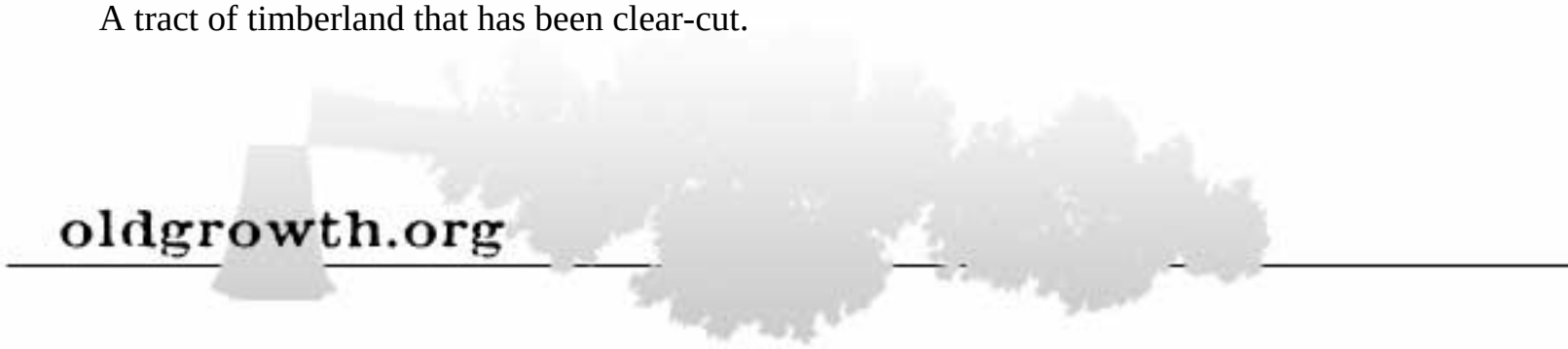

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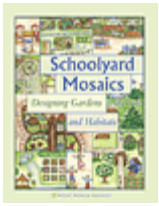

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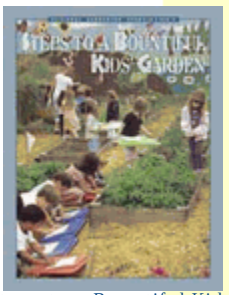

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Teamwork

Unit

Worm Bin Project Unit

On this page:

- Unit Description
- Objectives
- Materials and Resources
- Unit Lesson Plans
- Relation to Standards
- One Computer versus Many

- **Grade level:** Middle Elementary
- **Subject Area:** Science

Unit Description

Jackie Applin and her third grade class, the Applin Dumplin' Gang, at Newberry Elementary School in Newberry, MI, conducted a project in which they learned about decomposition of waste and the life cycle by creating and maintaining "worm bins." The project gave them an opportunity to collaborate and learn with students at another school in Michigan. For more on the Applin Dumplin' Gang's experiences with the worm bin project, you can check out Jackie's teacher case. For now, read on in this unit to learn how you can do a worm bin project.

In this unit, students will learn about decomposition and the life cycle by creating worm bins. Through direct observation, they will develop an understanding of the effects different organisms, including humans, have on one another. They will collect and share scientific data with students in another school over email. Such activities will give students an opportunity to explore scientific concepts in a manner that makes science more personally relevant and meaningful.

Students will be able to collect background information on the worm bin project using some of the resources provided as well as directed Internet and library searches.

The plans for this unit are tailored to fit classroom situations where students and teachers have access to several computers that have internet access. To accomodate the fact that few classrooms will have access to a computer lab with full Internet access, students will work in research groups to explore internet sites and conduct internet research.

Objectives

1. Students will learn more about decomposition and the life cycle.
2. Students will use the scientific method to pose and test hypotheses related to worms, decomposition, and plant growth.
3. Students will collaborate with their peers by sharing data and observations via email or teleconferencing.
4. Students will present their findings in a variety of formats: graphically, pictorally, verbally, orally.
5. Students will learn about the resources available on the WWW/Internet through research and guided browsing.

Materials and Resources

1. Hardware requirements: You will need a modem and phone line.
2. Software requirements: You will need an Internet browser software package, preferably Netscape. You will need an email software package like Eudora or FirstClass. You will also need ClarisWorks, or another integrated software package that has word processing and graphing capabilities.
3. Network/Internet requirements: At least one computer with an internet connection.

Unit Lesson Plans

1. Lesson One: Introduction to Worm Bin Project. Students create worm bins and begin worm bin activity.
2. Lesson Two: Collaboration Online. Students organize into small, collaborative groups and match up with partner groups at another school. Collaborative groups of students collect and exchange data and observations related to the worm bins with their partner group.
3. Lesson Three: Growing Plants with Worm Castings. Students test worm castings for content using a soil testing kit or through a 4-H extension office.

Students use the worm castings to plant seeds, hypothesizing which castings will best sustain plant growth and why. Collaborative groups of students may choose to work again with their partner groups at the other school.

4. Lesson Four: Decomposition, Soil, and Life Cycle Research. Students conduct background research on the decomposition process, soil composition, and the life cycle using the resources provided here and directed Internet searches. This research can help students answer any questions that may arise out of the Worm Bin project. It can also enhance the content of the presentations students will develop in their collaborative groups in a later lesson.
5. Lesson Five: Presentation of Findings. Students compile and format their findings from the Worm Bins, the plant activity, and from their Internet research into "scrapbooks." They may wish to prepare their scrapbooks graphically, pictorally, or in written form; schools that have the capability may publish these presentations on the WWW. Students also give short oral presentations of their findings.

Relation to Standards

We have drawn on Michigan state science standards projects and the national science standards projects of the the National Research Council and the American Association for the Advancement of Science in the development of this unit. We feel that these standards projects provide excellent guidelines for teachers on how to focus science work in their classrooms.

One Computer versus Many

The lessons in this unit are designed so that students can work in collaborative groups as well as in a whole-class format, the idea being that each group works at a computer with an Internet connection and integrative software. If the classroom has only one computer with an Internet connection, collaborative groups can still be used. In this case, a block of time can be set aside each day for work on the worm bin project and seed planting lessons in which collaborative groups take turns fulfilling their duties. For instance, one day during this block of time, group 1 can feed the worms or plants and note the amount of food. While group 1 is feeding, group 2 can email its partner group at a different school to report on the status of the worms or plants from the previous day or several days ago. Group 3 can discuss the kinds of things they'd like to share with their partner group when it is their turn to email. The next day, groups can switch duties.

A similar tack can be used for the Internet research and data presentation lessons. While group 1 researches worm, plant, decomposition, soil, and/or life cycle information on the Internet or organizes their data using ClarisWorks or the HTML editor, other groups can conduct traditional library research. They can look in books

and magazines to determine if there are any pictures or sounds they'd like to have that might be available on the Internet so that when it is their turn, they can make valuable use of the time. They can also discuss options for presenting their data; when it is their turn to use the computer, they will have developed some semblance of a game plan for working efficiently.

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Science

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Vermicomposting Lunchroom Wastes: New Manual for Schools and Small Businesses

Disposal of food waste has long been a nasty problem. Soggy, rapidly decomposing food residuals are messy to handle, cause obnoxious odors, and may attract vectors and other pests. Kitchen sink garbage disposals only add to the problems and costs by requiring up to eight gallons of water to dilute one pound of food waste. Sending food waste down the sink doesn't solve the problem; it only transfers the problem to wastewater facilities. Home composting and vermicomposting rank highest in the hierarchy of environmentally preferable options for managing food waste. But not all food waste is generated at home. Schools, restaurants, hotels, businesses, and institutions such as hospitals, military bases, prisons, etc., generate tons of food waste that must be collected, hauled and disposed or composted. Is there a cost-effective and environmentally beneficial method of processing food waste on site for these situations? Mid-scale vermicomposting offers a potential solution for some facilities, but where does one go to find a "how-to manual" of instruction for such a project?

Binet Payne's *The Worm Café: Mid-Scale Vermicomposting of Lunchroom Wastes—A Manual for Schools, Small Businesses and Community Groups* tackles the problems of implementing a successful waste reduction and vermicomposting program. Savings of $6,000 in collection and disposal costs were achieved in the first year of Payne's Laytonville, California school project. Curtailing the practice of washing food waste down kitchen sink garbage disposal systems meant that an estimated 103,000 fewer gallons of water a year were used. Additionally, students, teachers and school staff learned that the virtues of reducing, reusing and recycling produce benefits beyond cost savings. They discovered abundant learning opportunities in a project-based curriculum.

Before embarking on a mid-scale vermicomposting project, it is mandatory that a waste audit be conducted. How much food waste is generated per day? per week? per month? A two-week waste audit during which food waste is weighed will help determine the number of bins to construct and how many earthworms are needed to process the waste. Two common rules of thumb are suggested for estimating stocking rates and space requirements: Use one square foot of surface area to bury one pound of food waste each day and use two pounds of earthworms for every pound of food waste added to the worm bin.

Easy directions for building worm bins from lumber are provided. Four-foot-by-eight-foot bins with plywood bottoms and lids may be set on railroad ties and cinder blocks. Materials for each bin cost about $100 and each bin requires approximately two hours to construct. Where warm weather is a concern, worm bins may be placed in shaded areas (under trees), next to buildings, or covered with shade cloth.

The Worm Café offers a number of great suggestions that are imperative for the success of any vermicomposting program. How do you teach children and adults to separate their waste? Use clearly labeled containers (trash cans) for each of the following: veggie wastes (worm food),

protein foods (meat, milk and cheese), bottles, cans, bags, and "yucky trash" (i.e., non-recyclables such as plastic food bags, napkins and tissues). While napkins and tissues are considered paper waste and may be included in some managed vermicomposting systems, health and safety requirements suggest omitting these in school programs where students might come into contact with them.

How can you obtain bedding (bulking agents, carbon sources that, with food waste, allow earthworms to more effectively process waste)? Laytonville's pre-school, kindergarten, and grades one through eight generated paper waste consisting of discarded newsprint paper, book orders and colored construction paper. School district offices, medical clinics and other businesses were glad to get rid of their waste paper, often supplying paper already shredded because of its confidential information. The school eventually built a "Shred Shed" that allowed for storage and shredding of paper to be used in the worm bins.

Binet Payne demonstrates a genuine concern for the totality of her project that includes building healthy soil as well as processing organic waste. Since much of the vermicompost her school's worm bins produced would eventually end up in the school garden, Payne wanted to know what could be learned about the presence of toxic substances that might be found within inks and colored papers. "Before I began using the vermicompost produced in our bins directly on our school vegetable garden, I wanted to be certain that it was safe, " Payne writes. A soil laboratory confirmed that insignificant levels of toxic substances (and therefore, not harmful) were found in the vermicompost sent for testing.

Payne communicates a refreshing attitude and approach to the subject of "unwanted critters" in the worm bin. Many vermicomposters are easily annoyed by the presence of flies, maggots, and other "pests" they find lurking in their worm bins. Many folks typically ask, "What should I do about these pests?" Payne instead looks at the worm bin as an ecosystem, occasionally out of balance but able to re-establish balance over time. This is truer for larger systems (mid-scale and up) than for smaller home vermicomposting units. "Throughout all of our trials and errors," Payne writes, "we found that, unlike smaller vermicomposting systems, mid-scale systems are more tolerant of a wider variety of conditions that in smaller systems can cause major problems."

Excellent tips are provided in the chapter "Working Your Bins," where the processes of adding food waste, turning the contents of the bin, and encouraging earthworms to migrate laterally are described. Using her school's four-bin set up, Payne provides diagrams that show how food waste can be rotated over a 16-week period. Payne suggests using a finishing box for holding harvested vermicompost while it continues to be broken down (finished) by the microorganisms in the bin.

In any waste management system, it is important to plan for contingencies. What happens if there is more food waste than your vermicomposting system will handle? This may happen at the beginning of a new project, particularly if the amount of earthworms to be used has been underestimated. If on-site thermophilic composting is available, an enclosed bin for handling extra food waste should be constructed or purchased. Where does the protein food waste go? Overall, this represented a higher proportion of the total cafeteria food waste (9,360 lbs.) than the vegetative food waste fed to earthworms (3,600 lbs.). Laytonville supplied this protein food waste to chickens and pigs, but Payne did not mention the particulars involved in transferring this waste.

The appendices, bibliography and index supply helpful information amounting to just under half

the total number of pages. Classroom teachers will benefit tremendously from the checklist, posters, forms, lesson plans, work sheets, and annotated list of classroom materials. This is clearly a book about teaching vermicomposting written for teachers by an experienced teacher! If you are an educator, you'll give this book an A+.

The Worm Café is right on target for setting up a school vermicomposting program. Although Payne alluded to the possibility of selling earthworms and vermicompost for school fund-raising, no details were provided. It would have made the book even more valuable if a few ideas about the commercial side of vermicomposting could have been shared. While this book would be helpful for setting up other vermicomposting projects at small businesses and institutions, its appendices make it clear that Payne has written *The Worm Café* primarily for schools. A chief criterion an institution (hospital, military base, etc.) or small business would have in considering a plan to vermicompost its food residuals is, how much will the new system cost to set up and run, and what will be the savings? Businesses are typically profit-driven and cost-conscious. Some are environmentally sensitive, or at least would like to be thought of in that way. There is still the need for a similar manual that would focus on the cost benefits of on-site vermicomposting, including figures for initial investment, savings on the costs of diverting the organic waste, savings on water usage, savings on use of fertilizers and soil amendments when vermicompost is used for on-site landscaping needs, etc. A convincing case for considering on-site vermicomposting can be made when the written material meets the needs and answers the objections of the intended reader. *The Worm Café* leaves no doubt that on-site vermicomposting can and should be done at every school facility. It also opens the door for institutions and small businesses to consider doing the same.

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P.O. Box 1134 Fax: (541) 476-4555
Merlin, OR 97532 Home

The Worm Cafe: Mid-scale Vermicomposting of Lunchroom Wastes

This manual describes how a teacher and her students developed a system to compost lunchroom waste with worms and save their school $6000 per year. How they performed a waste audit, garnered support from school personnel. Discusses bins, bedding, maintenance, harvesting and using castings in the school garden. Contains earthworm diagrams, bulletin board materials, quizes, letter to parents, charts, and dozens of resources.

Author: Binet Payne

Specs: Paperback, 8 1/2 x 11, 180p, 7 appendices, annotated references, bibliography, index. Flower Press.

ISBN: 0-942256-11-5
More info/T.O.C/Sample chapter

Price: $29.95

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:: Articles

In this section you'll find articles spanning the full history of *Worm Digest*, from our very first issue in 1993, through our current issue and covering topics as wide-ranging as the ways that worms are used to better our environment. This is our more advanced reading section – those completely new to worm composting should visit our Getting Started section first. **Ok readers, dig in!**

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Your Ad Goes Here
:::

Worm Castings Worth Their Weight
by S. Zorba Frankel *from issue #35*
Some of our editor's thoughts on the directions that the worm industry, and the organics industry, are taking us.

The Earth Moved!
by S. Zorba Frankel *from issue #35*
The Earth Moved: On the Remarkable Achievements of Earthworms is Amy Stewart's fascinating exploration of the amazing work that earthworms have done. We've got a book review and tour dates here. Enjoy!

Resources for Educators
by S. Zorba Frankel *from issue #34*
A list of resources chosen to help educators get started with worms in the classroom, expanded from our printed issue #34.

Bin Bug Bingo!
by Deborah Newton-Hair *from issue #34*
Read how this elementary school teacher helps to turn composting education into a carnival!

Earth Day 2003 - Our Tenth Anniversary
by S. Zorba Frankel *from issue #33*

What Have We Learned From B&B?
by S. Zorba Frankel
Shut down in March 2003 by the State of Oklahoma, B&B Worm Farms, Inc. was this country's largest worm buy-back contract seller. They claimed there existed an enormous market for redworms. Unfortunately, we don't see a market of anywhere near that size. B&B built a very short-lived market that would benefit only their company.

Use Your Information Resources!

by Roy Slocum *from issue #32*
The Internet and telephone are powerful tools that can help you evaluate worm business offers.

If It Sounds Too Good To Be True...
by S. Zorba Frankel and Kelly Slocum *from issue #32*
Your friend tells you of a business opportunity in a growing industry, doing work that benefits the environment, and says you can earn BIG money. All it requires is a minimum $10,000 buy-in, which they say you'll earn back in a little over a year. You're excited, to say the least. So were about 2500 other people...until the scheme collapsed.

Worm Bin Critter Gallery
by S. Zorba Frankel
The worm bin is a complex ecosystem containing many different types of fascinating organisms. Our critter gallery will introduce you to them.

Earth Day Worm in Workshop a Success!
Each year, on Earth Day, Worm Digest leads a large children's workshop. One hundred children paint, set up and learn about their first worm bins, and we hope, begin a lifelong practice of composting. *Note: this year's workshop was held April 19th, 2003.*

Tea Maker Casts Off Crates!
by S. Zorba Frankel *from issue #31*
TAZO's cast-off tea shipping crates, from India and Sri Lanka, are easily converted into usable worm composting bins by Worm Digest staff.

Recipe For a Great Worm Workshop!
by S. Zorba Frankel *from issue #31*
Worm Digest staff encourages you to cast aside any fears and lead a workshop. You will never know how rewarding it is until you do it.

How Did Perionyx excavatus Appear in My Beds?
by Kelly Slocum, Bon Terra, Inc.
"I'm a worm grower and I've found these blue/violet, iridescent worms in my beds that appear to be Perionyx excavatus. How did they get into my beds when I originally only had Eisenia fetida? How can I get them out of there?"

Euros and Tigers and Reds, Oh My!
by Kelly Slocum, Bon Terra, Inc.
Which worms do we want in our worm beds and which do we actually have? These and more quesions are explored in this article, drawn from a growers manual written by the author.

**** A New, Inexhaustible Source of Energy Found in Classrooms! ****
by S. Zorba Frankel
Research shows that bringing worms into the classroom can lead to an astounding release of excitement, curiousity, and learning.

The Worm Composting Toilet
by S. Zorba Frankel
The experienced worm composter may wish to explore methods of safely processing human waste.

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worm business articles

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The Worm Buy-back Business
by S. Zorba Frankel and Kelly Slocum *from issue #25*
This ever-fascinating, controversial subject revisited!

Shouting Buy-back in a Room of Worm Workers
by S. Zorba Frankel *from issue #29*
Specifics of a certain buy-back arrangements, and a call for companies to use only current, complete, accurate worm information.

Can I Make Money With Earthworms?
by Kelly Slocum & S. Zorba Frankel *from issue #19*
Co-editors Kelly Slocum and S. Zorba Frankel encourage reason, and a healthy dose of self-assessment, when deciding whether or not to go into the worm business.

Buy-back Guarantee
by S. Zorba Frankel *from issue #14*
In 1996 we asked five worm business owners what they thought of the earthworm buy-back business arrangement.

Getting Started in the Worm Business: Further Resources
If you're looking for more information, here are our suggestions and references for a great deal more!

Pathogen Reduction in Vermicomposting
by Kelly Slocum *from issue #23*
This Orange County, Florida, study shows that vermicomposting can meet EPA requirements for producing class A compost. This 1999 study tested biosolids spiked with a number of pathogenic organisms.

A Need for Testing
by Susannah Tymms *from issue #13*
Early research on pathogen elimination through vermicomposting, from Melbourne, Austrailia.

Dendrobaena veneta -- For Bin, Bait, or Both
by Kelly Slocum *from issue #22*

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more general interest

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Preparing and Sending Worm Castings as a Gift
by S. Zorba Frankel *from issue #30*
Castings may be prepared and sent in self-sealing bags without losing much of their power as a plant growth enhancer...

Boosting Earthworm Populations and Fertilizing With Worm Castings
by S. Zorba Frankel
I want to improve my garden's soil. Should I buy worms to put in my garden? Should I dump redworms in there along with the worm compost?

Garden Partners
by Stephen White *from issue #12*
This avid Portland, Oregon gardener feeds worms in a gorgeous highrise "condo".

The KISS Plan
by Jim Jensen *from issue #18*
The KISS (Keep it Simple & Save) Plan for vermicomposting for farmers and others is designed to use established methods (an

extended windrow) and available equipment (a front end loader) to process large volumes of organic material into vermicompost. It is also easily adapted to the hobby farm scale. The plan suggests easy, appropriate technology to manage environmental factors and to control quality. The plan may be adapted to other situations or applications.

Worms Hospitalized

by Stephen White & Al Eggen *from issue #6*

This is the story of two Canadian hospitals that have chosen vermicomposting as a way of converting their food waste into a valuable product and putting it to use as a soil amendment rather than wasting it in landfills.

Is The Redworm An Earthworm, Too?

by Stephen White & Zorba Frankel *from issue #7*

When we say "Earthworm", what animal are we talking about, exactly? Should it include worms whose habitats are not the root zones of plants nor the deep subsoil? Years ago, we made our own decision on this naming issue.

Elementary Students In Oakland Wiggle Through Science With Worms

by Cindy Nelson, LITES Coordinator of Special Curriculum *from issue #10*

Worms wiggle their way into a science training program for elementary school teachers — and are a big hit (of course)!

Compost Tea or Leachate?

by S. Zorba Frankel *from issue #22*

Compost and castings tea are a carefully-crafted brew, not to be confused with the liquid that drips from a worm bin.

The Worm Man of Havana

by Matthew Werner, University of California, Santa Cruz *from issue #5*

Jorge Ramon Cuevas has been working since 1985 to use earthworms to convert organic wastes into fertilizers.

Scatalogical Reflections from a Vermicomposting Privy

by David Lee Hoffman *from issue #8*

David Hoffman of Lagunitas, California has built a two chamber vermicomposting privy that works well without electricity or human labor. Worms do all the "work", and for them, it's a pleasure!

Elementary Students In Oakland Wiggle Through Science With Worms

by Cindy Nelson, LITES Coordinator of Special Curriculum *from issue #10*

The California LITES program (Leadership Institute for Teaching Elementary Science) includes a one day training called "worm day"!

Experimental Evidence for Castings' Effectiveness

by Philip Snow, Earthworks, Suisun, CA *from issue #4*

A test plot of tomatoes grown with earthworm castings shows that this natural fertilizer can make a BIG difference in production.

Worms Riding High

by Stephen White *from issue #3*

Worms are riding a high wave of publicity and we aren't the only ones to be touting their benefits.

It's a "Squirm" of Worms!

The squirm of worms joins gaggle of geese, pod of whales and Pride of lions as a collective noun.

:::

Front Page | **Getting Started** | **Articles** | **Building Your Bin** | **Back Issues** | **Worm Bin Reviews** | **Corner Market** | **Cyber Worm's Links** | **Calendar** | **Worm Forum**

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COMPOSTING RESOURCES FOR TEACHERS AND STUDENTS

This composting education page for teachers provides links to composting curriculums, graphics, and resources all over the Internet.

Online Composting Curriculums and Project Ideas

A number of composting curriculums and project ideas are available online:

Composting Experiments at
http://www.gnb.ca/elg%2Degl/0372/0003/0013-e.html
New Brunswick Department of the Environment has put together some experiments to help students understand how composting helps earth and plants. Complete instructions are online.

Introducing Kids to Composting at
http://www.sdearthtimes.com/et0498/et0498s10.html
San Diego news article with advice on introducing kids to composting.

Recycle City at http://www.epa.gov/recyclecity
Mostly recycling, but does have the opportunity to select Municipal Composting.
Clean Up Dumptown Interactive Game lets you act as City Manager to try collection of compostables and other recycling and litter prevention programs to clean up the town. You will see both the results and the costs of your decisions.
A Town that Recycles
Click on the map to zoom into the town and go inside the buildings. Once there, you can click on the various areas of the rooms to learn about the town's efforts to recycle, reuse, and reduce waste.
Use Your BrainPower to answer these questions about recycling.
Information for Teachers gives teachers direction in using this site with their classroom.

Cornell Composting at
http://www.cfe.cornell.edu/compost/schools.html
A wealth of information for teachers and students. Suggested lesson plans, student projects, sample quiz, reasons for teaching composting and integration with other subjects.

Environmental Protection Agency (EPA) Waste and Recycling Curriculum at
http://www.epa.gov/region5/teachers/curriculumwaste__recycling.htm
Includes teaching aids and curriculum guides. A good resource for recycling.

Composting Education
1. Teacher Resources
2. Master Composter Course
3. Newsletter
4. Hand-outs
Product Sources
1. Compost
2. Compost Bins
3. Tools
Return Home

RotWeb Home Composting Information Site at
www.a-horizon.com/compost/compost_menu.html

Don't Bag Leaves/How to Compost Slide Show at
http://aggie-horticulture.tamu.edu/earthknd/compost/compost.html
From Texas A&M Horticultural Site. Absolutely wonderful! At 12 mg, it takes a while to load.

Composting and Recycling Curriculums for Sale

I have not seen these curriculums, therefore I cannot recommend them. Use the links to see descriptions and judge for yourself.

Association of Vermont Recyclers at
http://www.sover.net/~recycle/pubs.html
Cornell Waste Management Institute at
http://www.cfe.cornell.edu/wmi
Environmental Education Links at http://eelink.net/

Clip Art Graphics

The following sites provide compost clip art appropriate for use on classroom handouts, announcements, etc. Be sure to read the conditions for use -- source usually requires non-commercial use.

Waste Prevention Clip Art at
http://www.ciwmb.ca.gov/gallery/default.htm
Art from the California Integrated Waste Management Board on composting, recycling, and other topics.

Our Home Page / Search This Site / Contact Us

URL: http://www.mastercomposter.com/educate/teachers.html
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Teacher's Page

This Web Site contains a full Educational Unit that can be used by schools, or even by parents at home, to educate their children on the benefits of waste minimisation, while integrating the various activities into many different subjects.

The Unit contains lesson ideas and suggestions for use with primary school aged children. To take advantage of all the activities, you will need a Reln Worm Factory and a supply of Compost worms.

Educational Unit

Code of Ethics

Before commencing any activity, create a code of ethics for the care of worms in your classroom situation. eg:

1. **Only use the bare minimum of worms to carry out the experiment.**
2. **Ensure care in handling worms so they are not harmed during capture, transportation, experimentation and release.**
3. **Feed your worms regularly, and ensure that they do not dry out.**
4. **Worms must be adequately fed and watered if left in the classroom over holidays.**
5. **Worms should be returned to the living environment at the end of the study.**
6. **What happens to excess worms from the Worm Factory?**

For further information see the '**Frequently Asked Questions**' for the RELN Worm Factory.

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For Teachers and Students

- Waste Audits for Schools
- Recycling Activities for Children
- HomeMade Paper Recipe
- Waste Reduction

The Recycling Council of Ontario's e-mail address is: rco@rco.on.ca.

Back to RCO Factsheets page.

Peat Moss and the Environment

Environmental Concerns

Home

There are some people who are misinformed about the harvesting of peat moss. The CSPMA is committed to providing accurate information to the public on harvesting and environmental issues.

One common misconceived notion is that peat is "over harvested" and that "prices will inevitably rise". Statement's like this are incorrect. Peat moss is not being over-harvested and prices are lower today than they have been in the past 10 years. Here are some important facts to set the record straight:

Harvest Issues

There are more than 270,000,000 acres, 25% of the world's supply, of which our industry harvests on less than 40,000 acres, or one acre in 6,000.

Peat is renewable and in terms of its accumulation, peat in Canada is growing more than 70 times as fast as it is being harvested. [According to an issue paper entitled "Canadian Peat Harvesting and the Environment," published by the North American Wetlands Conservation Council (Canada)]

As well, we know that under the right circumstances, sphagnum moss will re-establish itself on a harvested bog. Soon thereafter, from this collection of mosses, peat will accumulate, re-establishing a layer of peat that will continue to grow.

Because a single bog can be harvested for between 15 and 50 years before they are left for restoration, harvesting has been completed on less than 3,000 acres. There are good examples of harvested bogs in Canada where more than one foot of sphagnum moss has re-grown, unaided, during the 10 to 15 years since harvesting has ceased. These bogs look like and provide the functions of virgin bogs.

Even though Canada does not have peat supply concerns, the industry is looking for ways to accelerate peat bog regeneration. Until recently, peat bogs have been left to regenerate, a process that can take up to 20 years. New research in ways to restore bogs quickly, indicates that time can be shortened to five to eight years.

The research projects, in which the industry has invested $1 million, include transplanting live sphagnum plants, seeding spores of sphagnum taken from live plants, and covering the harvested bog with the top spit from a living bog. This research is complete now and the results are excellent. From the techniques developed through the research, the research team, in cooperation with our Association, has produced a restoration instruction manual entitled Peatland Restoration Guide.

It will take hundreds of years to replace all the peat that was removed, but even while it's growing we will have is a peatland that resumes the most important functions of a bog:

- filtering water,
- acting as a water collection basin,
- accumulating carbon, and
- providing habitat for flora and fauna.

The one function we cannot replace is a virgin bog that stores geo-paleantological history. For that reason, it is important to identify bogs for conservation in all areas of Canada.

Peatlands will regenerate themselves and it is the policy of the Canadian peat industry, and supported by government, to ensure peat is a sustainable resource. The Canadian peat producers have adopted a strict Preservation and Reclamation Policy that calls for, among other things:

- identifying bogs for preservation through environmental assessment;
- using careful harvesting techniques so that restoration can be readily achieved;
- leaving at least three feet of peat at the bottom of the bog; and
- returning of harvested bogs to functioning wetlands.

There should be no concern with continuing to use peat moss as the base of growing media in North America. The resource is huge, the amount of extraction small by comparison and the industry and government are committed to sustainable development.

Price

With respect to pricing issues, the industry is very competitive and good supply is readily available. The current price gives the customer excellent value for the money.

Should you have any other questions regarding Canadian sphagnum peat moss and the environment, we invite you to e-mail us for a prompt reply.

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Peat Moss and the Environment

Environmental FAQ

Home

What is Canadian sphagnum peat moss?

Canadian sphagnum peat moss (CSPM) is partially decomposed sphagnum moss. Sphagnum's large cell structure enables it to absorb air and water like a sponge. Although peat moss does not contain nutrients, it does adsorb nutrients added to or present in the soil, releasing them over time as the plants require. This saves valuable nutrients which are otherwise lost through leaching.

Is it true that it takes several thousand years for sphagnum peat moss to form?

No. Peat forms at a rate of 1 to 2 millimetres a year. According to a recent study by the North American Wetlands Conservation Council (Canada), harvested peatlands can be restored to ecologically balanced systems within 5 to 20 years after peat harvesting.

Isn't there a shortage of peatland in Canada? Isn't harvesting peat moss depleting these areas of wetlands?

No. There are more than 270 million acres of peatlands in Canada. Of that, only one in 6,000 acres (or .016 percent) is being used for peat harvesting. Canadian sphagnum peat moss is a sustainable resource. Annually, peat moss accumulates at more than 70 times the rate it is harvested. Harvested bogs are returned to wetlands so the ecological balance of the area is maintained.

Can the supply of peat moss be completely depleted?

No. The bogs that are being harvested will be restored to functioning wetlands. In addition, there are millions of acres of bogs in national parks and other preserves that can never be harvested.

What is the CSPMA Preservation and Reclamation Policy?

Canadian Sphagnum Peat Moss Association (CSPMA) members agree to abide by the reclamation policy for all new bog development. It includes:

- Identifying bogs for preservation.
- Leaving buffer zones of original vegetation to encourage natural succession after harvesting.
- Leaving a layer of peat below harvesting levels to encourage rapid regrowth.
- Returning harvested bogs to a wetlands ecosystem, or, if that's not possible, to other wildlife habitats or agricultural production.

For more information on this topic, please go to the Preservation and Reclamation Policy.

What is Sportrichosis and does it come from Sphagnum peat moss or Sphagnum moss?

You may have read about a fungal disease call Cutaneous Sporotrichosis, a chronic infection identified by skin lesions. The fungus which causes this disease has been found in several kinds of organic material and, because in extremely rare cases this disease can cause death, gardeners are rightfully concerned about protecting themselves from contracting it. Unfortunately, however, some of the information circulating about how gardeners can contract this disease has been inaccurate. It confuses two separate products; one of which is known to carry the fungus and one of which does not.

One of the materials know to carry the sporotrichosis fungus is sphagnum moss. This product is frequently being confused with sphagnum peat moss, a soil conditioner used by gardeners. The difference is an important one. While there have been cases of sporotrichosis resulting from handling sphagnum moss, There have been no cases as a result of handling sphagnum peat moss. Sphagnum moss and sphagnum peat moss are not the same product, as many avid gardeners know.

Sphagnum moss is the living moss that grows on top of a sphagnum bog. The fungus sporotrichum schenckii is known to live in this growing moss.

Sphagnum peat moss is the dead material that accumulates as new live material grows on top and exerts pressure on the peat moss

below. The fungus is not known to live in the levels of a sphagnum bog where peat forms. Harvesters of horticultural peat moss remove the top few inches of the live sphagnum moss and only harvest the peat from he lower layer.

“Living” sphagnum moss is used in the floral industry to make wreaths and to line hanging baskets. Workers in the industry have been warned to protect themselves with gloves and heavy clothing to avoid puncture wounds or scrapes. Gardeners wishing to use sphagnum moss to create their own baskets or for other uses should simply follow the same advice: Wear gloves and long sleeves to prevent coming into contact with the dried moss.

Gardeners worldwide use sphagnum peat moss as a soil amendment because its unique cell structure enables peat to:

- Aerate plant roots by loosening heavy clay soils;
- Add body to sandy soil; and
- Save water by absorbing and holding moisture

Peat moss is not only effective, it’s organic and safe to use.

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How does Coco Peat do this?

1. Coco peat can be used for seed starting, bedding plants, planters, gardens, container plants. Anywhere you would use peat moss. The properties of Coco Peat make it resistant to bacterial and fungal growth.
2. Coco Peat holds water rather than shedding it like traditional peat does! It holds 8-9 times it's weight in water.
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Peat moss is strip mined from peat bogs which are a non renewable sensitive eco-system.

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Coco Peat is made from coconut husk fiber: a by product from the coconut harvesting process.

Coco Peat is guaranteed to be weed and pathogen free.

Easy to use!

1/3 cubic foot brick is: $3.00 each

release nutrient to plants for extended periods of time. It also has great oxygenation properties which is important for healthy root development.

4. It has a pH of 5.2-6.8 which is neutral to slightly acidic. This makes it great for alkaline garden soils.
5. Easy to use! Just put your compressed Coco Peat brick in a container, add 4 quarts of warm water and let it sit until the water is absorbed, fluff it up and you are ready to use Coco Peat!
6. Coco Peat can even be reused for up to 4 years!
7. It makes a great bedding material for worm bins! It's actually good for them and increases worm growth by 25%.
8. Coco Peat is very slow to disintegrate, whereas peat breaks down within two years after application, Coco Peat only begins to break down when it is 10 years old, long term benefits.

Our customers and we are amazed at how well Coco Peat does for seedlings and in general. All our seedlings have done beautifully with it as a starting medium! Absolutely no damping off. Seedlings have exhibited excellent foliar and root growth.

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Jagath M. Yapa
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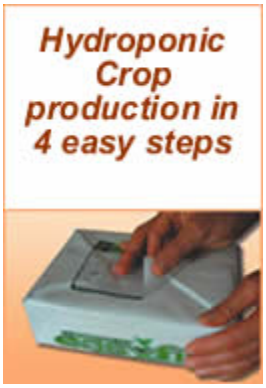

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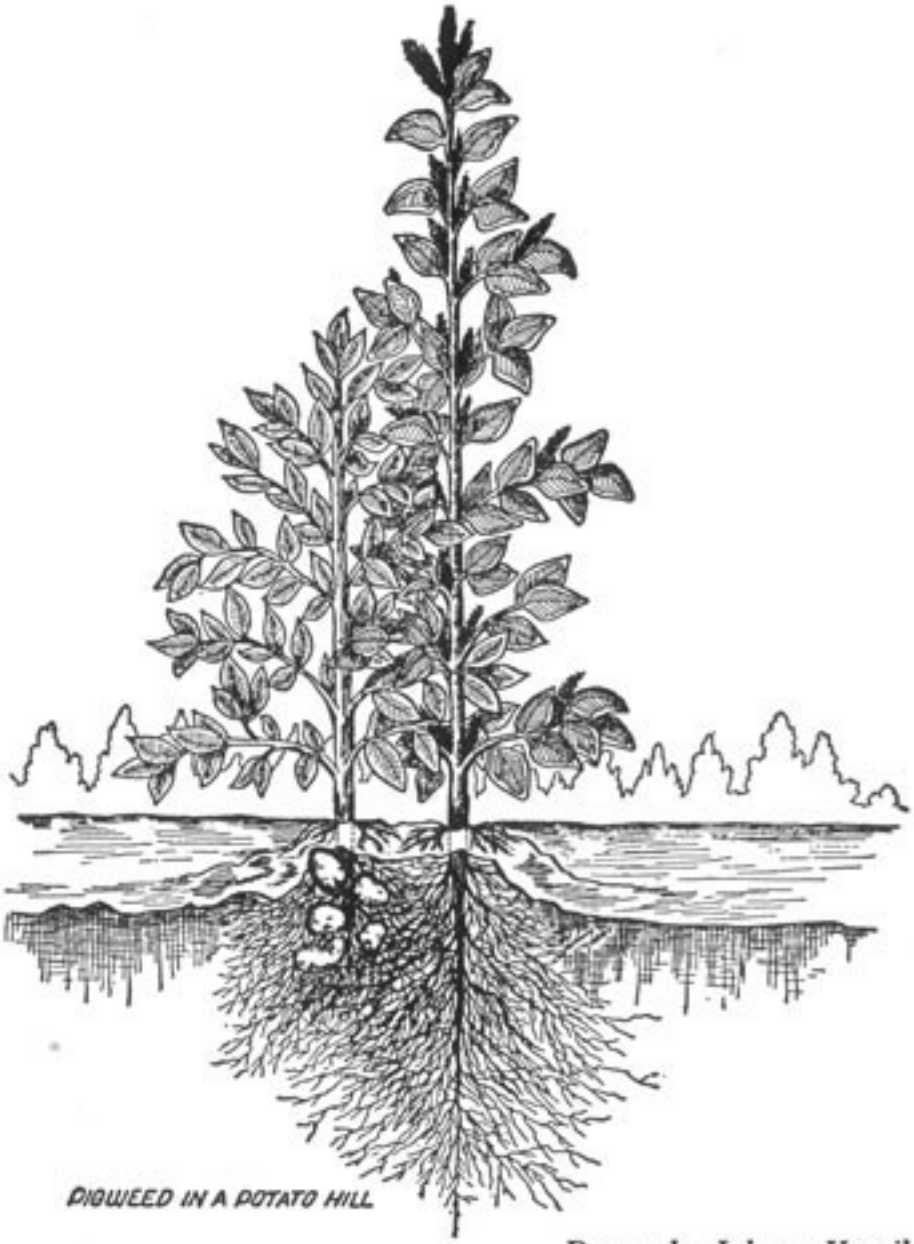
Weeds -- Guardians of the Soil

by Joseph A. Cocannouer



PIGWEED IN A POTATO HILL

Drawn by Johnny Vancil

1. Weeds and Youth

DURING my early boyhood years on the farm, weeds spelled misery. At the first break of spring, weeds carpeted the land -- yesterday drab; today dense green everywhere. And mother saw every weed as a separate, individual enemy with which we must join battle.

"Bring the hoes from the loft and file them right away, boys!" I can hear her voice now, coming out of the long ago. "We simply mustn't let the pesky things get ahead of us!" I wonder how many weed hoes I have filed in my dreams!

Our little Kansas farm, even at that period, was in sore need of what *controlled* weeds could have done for it. But weed superstition reigned then as it reigns today. We hated all weeds in all situations because we hadn't learned to interpret some of the simplest laws by which Nature maintains the productiveness of land.

Even during those trying years when I could see nothing good in weeds save as potherbs or as feed for hogs, I always liked to pull or hoe weeds for Sol Benson. Sol was a successful farmer who owned considerable land -- and who didn't treat me as a kid as did so many other farmers. Sol also usually gave me a few cents extra when he paid me off.

A certain day in Sol Benson's cornfield started me on a research journey that has spanned a half century. I happened to be hoeing in one of Sol's best fields, which I had contracted to clean of weeds for a definite sum. The corn was tree tall and the morning promised a scorching day. This particular field, fortunately for my feet, was quite solidly carpeted with purslane -- the dirt where the sun reached it was hot. "Pusley" was then a much more common weed in Kansas cornfields than it is now. (When I not long ago queried a young farmer why that was so, his reply was characteristic: "Good cultivatin' machinery and weed sprays -- we're gettin' the weeds licked!" I didn't say what I thought then. His fields spoke for me.)

I was soon so absorbed in those weeds in Sol Benson's field that I forgot everything except to keep my toes away from the edge of the hoe. With great spreads of pusley rolling up over my feet, my battered straw hat pushed back on my head and the sweat trickling down my face --

"Hold on there!" The voice was right behind me.

I turned -- and there was Sol Benson grinning at me. Then Sol very quickly seemed to forget that I was present. Very seriously he started to examine the roots of a large pusley plant he had brought with him. It wasn't one of the plants I had hoed up, for it carried a husky set of roots. Sol was fingering the pusley roots thoughtfully. I jerked my hoe loose and walked closer to him, wondering what there was about that pusley plant that made it so interesting.

Sol lifted his head quick-like then, same as he always did when he was going to say something important. "Joe," he said; "Joe, I been watchin' this pusley weed in my fields for a long time, and I've come to the conclusion that it not only don't do any harm, but it does good! This thing of considerin' all weeds as bad is nonsensical. Lot of guessin' without knowin', way I look at it. So I aim to do some guessin' of my own -- we're goin' to stop cuttin' pusley out of my corn!"

I stared at Sol Benson for a long moment, completely dazed. "But -- but pusley is weeds!" I finally managed to gulp. "Weeds is allers bad in fields where crops is growin' -- "

"That's only what people *think*!" Sol interrupted me sharply. "I'm convinced we been thinkin' wrong about weeds. Look here -- " he showed me some broken corn roots scattered among the pusley roots. "Know what that means? It means that the pusley roots are openin' up the dirt for the corn roots, so the corn can go deeper into the ground and get more to eat. Now come with me and I'll show you somethin' else -- "

Sol went striding away through the corn and I trotted along behind him, still not sure he wasn't having a fit. Of all the silly ideas -- pusley makin' a road so the corn roots could go deeper into the ground!

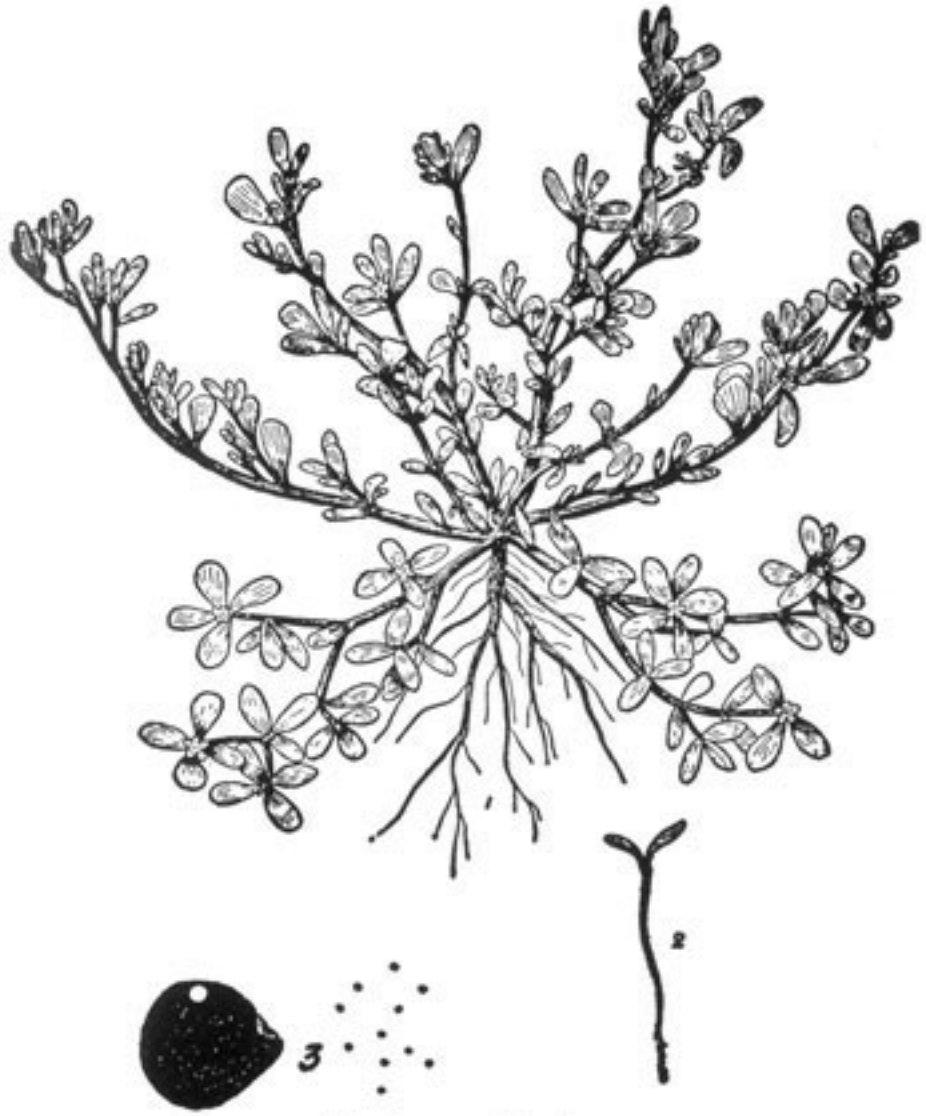
When we came to a part of the field where there was almost no pusley, Sol stopped and began pointing out the corn to me. "See the difference?" he said. "Not near as good as where the weeds are thick back there. Same kind of dirt, too. Somethin' is makin' a difference in that corn, and I figure it's the pusley. It's like that in all my fields. Where the pusley is thickest I get my best corn. Most farmers will say the corn is doin' good in spite of the pusley. That ain't it at all! The pusley is ***helpin***' the corn to grow better."

I could see a difference in the corn all right, but the very idea of the pusley being responsible for that difference! "Sol, it jist must be somethin' else!" I told him courageously. "I know yer a good farmer and all; but nobody thinks that weeds is good for anything but hog feed and greens -- '

"I know they don't! Remember, people used to believe the world was flat -- "

"But that was 'cause people used to be ignorant and superstitious-like -- "

Amd right then something hit my brain a terrible wallop. People had been ignorant and superstitious and all, about the shape of the earth. Could it be that people were superstitious about weeds, too? Somebody had to discover that the earth isn't flat. And Sol Benson was smart enough for most anything -- even smart enough to discover that pusley could be helpful to corn!



Purslane or Pusley

Sol Benson has long since departed from the earthly scene. His name has been forgotten save by a few. The pusley of those yesteryears is also gone -- most of the present soil on that Kansas farm of my boyhood will not support it.

But, starting with Sol Benson's cornfield, I can see a winding trail; a dim trail at first, winding its way persistently into the years, traversing many parts of my own country and many foreign lands. Along this trail came soil studies in numerous regions of Asia, with its ancient agriculture; the desert lands of Africa; the semi-wild man and his crude farming; Europe offering the best in modern soil science. And with "weeds" ever a major part of every picture or episode where soil fertility entered in.

During much of my youth my weed trail was beset with skepticism and doubt, despite my confidence in Sol Benson's wisdom as a farmer. Weeds helpful to the crop with which they were growing -- all evidence seemed against the idea. Then there were the teachings of my mother. Those would not give way until I had undeniable proof that her concept of weeds was wrong.

As I grew older, support of Sol Benson's conclusions poured in upon me, often from the most unexpected sources. Weeds could be friends of the land! Day by day this evidence drove me deeper into the study of Nature's laws which supported the evidence: the laws pertaining to the constructive relationship ever existing between soil and deep-feeding herbaceous plants.

Now as I look back across those years, I am able to evaluate more scientifically my varied sources of information: sound knowledge gleaned from a Pawnee Indian in his wigwam; a Chinaman fighting for survival on a small area of land and employing weeds as his fertilizer; from still wider acquaintance with the jungle man and his "mother weeds" on his primitive farm -- and coming close to understanding the science back of his procedures; or from some progressive American or European farmer who had discovered weed values and who was ready to support his findings with proof.

Then, too, there came further penetration into the natural laws of soil fertility; personal experiments -- all have convinced me that Sol Benson was a soil scientist who knew his pusley and its value in correct land management. Thus the chapters which follow.

Next: 2. Weeds and Weeds

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Weeds -- Guardians of the Soil

by Joseph A. Cocannouer

2. Weeds and Weeds

"WEED: any plant growing out of place." But who or what is going to decide when a plant is out of place? Mustard going to seed in a field of ripening wheat is certainly out of place, as are weeds that shoot up like a magic green carpet in a field of young sugar beets. But if a plant is strengthening the soil in a given location, according to the laws of Nature, it is not out of place as a fundamental in maintaining land productiveness.

Some plants always seem to be harmful: poison ivy, for instance, and puncture weed and dodder -- and many others. Some can be harmful under certain conditions: pigweeds growing so thickly that they smother both themselves and the domestic crop. Yet, there are situations a plenty where the wild plant is beneficial both to the soil and the domestic crop with which it may be growing. An example of this is pigweeds in a heavy-soil potato field, the weeds spaced far enough apart to permit strong root development without crowding the potatoes; or a combination of pigweeds and lamb's quarter and sow thistles, scattered thinly in a tomato garden or an onion patch -- or even in a cornfield. In such cases the weeds can become valuable "mother weeds" instead of pests.

In southeast Asia there is a wild plant that spreads in tangled growth along the edges of the fields of the native farmers, often creeping far out into the fields. No other wild plants in that region equal this one in spreading vigor. Though the Malays relish the young pods, farmers insist that it is a bad weed, since they must labor to keep it from growing too near their rice and vegetables. That bad weed in Malaya is the fore-parent of our American cowpeas. When I questioned the Malay farmers, they admitted they usually harvested their best crops near where the *payaap* was growing. Even so, in their estimation it was a harmful weed.

Nature may at times compel us to discover the value of her wild plants; her weeds. In pre-colonial times a group of explorers, after navigating the Amazon for a lengthy period, decided to strike overland to a point towards which they were heading, hoping

thereby to save weeks of time. The little band became lost in the jungles.

After many days of wandering, the men finally came upon a seemingly endless growth of vines bearing great quantities of pods filled with plump seeds that looked temptingly edible. But the explorers had already learned jungle caution. After considerable mental struggle, they decided to cast lots in order to choose a victim, who should risk his life by eating these *habichuelas*. Thus were our most popular beans discovered. Not only are these beans a staple article of food in many parts of the world; they are soil improvers wherever grown.

I call to mind an old woman in south China whom I saw gathering herbaceous wild plants from an almost barren hillside. She was creeping over the rocks and along the steep banks in search of a few wretched weeds that would help make her tiny plots a bit more productive. My guide explained that the old woman was looking for particular kinds of weeds, though he did not know in what way they were particular. I examined the plants after the Chinese woman had brought them to her field. They or their relatives are common in many parts of the world: two or three varieties of thistle, a poppylike plant, a milkweed and a spurge. There were others I did not recognize. The important thing was that those wild plants -- those weeds -- were treasures in that Chinese woman's desperate economy. They fed the soil that must feed her.

Once, while in Europe, traveling through rural Bavaria, I came upon a man who was cutting green weeds from the roadside, apparently to mix with the manure sweepings which he was also gathering from the road. Among his weeds were nettles, lamb's quarter, thistles, mallow, and bindweed. Immediately I wanted to ask questions, but soon found that my college German was of little use. I did manage to get an invitation from the man to visit his neat farm, where I was introduced to a daughter who spoke English.

The German farmer did not consider many of our common weeds harmful in themselves. According to him the harm came from the farmer's failure to control the weeds while they were growing in his fields. The German had a most efficient, simple method of handling barnyard manure. The manure pile was under continuous construction, and as the manure came from the barn or corral or roadway, it was stacked with layers of manure or litter alternating with layers of weeds. By this method of manure-pile building, the farmer explained, the amount of the final fertilizer was markedly increased through the addition of the food-filled weeds; and firefanging of the manure was prevented because the weed layers permitted proper aeration.

I examined one pile of this fertilizer that had already gone through the processing. The stac on the outside looked like any typical manure pile now and then seen in American barnlots. Inside, the pile resembled true compost somewhat, but was really just mellow, well-rotted manure of a superior quality. I have since wondered if this German farmer could not have been employing a fertilizer-making process handed

down from the Romans. The Catholic monks in Europe a few centuries back were known to have employed in their very efficient agriculture some of the teachings of Cato, who had lots to say on this subject.

While weed prowling in one of our midwestern states, I came upon a farm woman who had discovered that dry weeds were a real asset in successful gardening. When I first saw the woman she was collecting the weeds in a thick patch near her garden, and then carrying them to her vegetable plot where she had already made a sizable pile.

I crawled through the road fence and introduced myself. "Tell me," I said, "but aren't folks supposed to carry the weeds away from their gardens instead of onto them?"

"I suppose so," she smiled. "I guess I'm a little contrary. Amyway, I like to burn weeds on my vegetable plots. Am I scientific?"

"Decidedly! That's what interests me. May I ask how you happened to discover that weed ashes are especially good for your vegetables?"

"By experimenting, and through the smattering of science I learned in high school and college. One who has nibbled a bit at biology is likely to wish to try out new things with plants -- don't you think?"

(For a fuller discussion of burning, see Chapter 7.)

We then walked out into the patch from which she had been gathering her weeds. There were horseweeds, a lighter growth of lamb's quarter, annual ragweeds, and thistles: the usual farm weeds for that locality. I moved the dirt with my foot and pulled up several of the weeds, most of which revealed strong root systems. I also crumbled some of the fibrous, mellow soil in my hands, and as I did that I was taken back across the years to some of the weed coves I had known in the Cherokee Strip during my boyhood. "With all of man's knowledge of soil science, he is not able to produce a dirt like this," I told her. "And all built by the weeds themselves -- the very same weeds that give you excellent ashes for your vegetables."

She trickled a handful of the soil through her fingers. I could tell that she knew how to appreciate good dirt. "There's one thing I've found out about the soil in here: for some reason it warms up early in the spring. Even when there is frost in the ground elsewhere, I can get warm soil here for my seed boxes."

Her words brought back days in the Indian country when I often tramped the woods and hills with a hunter-naturalist who used to say to me: "If you wanta scare up deer on a blizzardy day, always make for a weed patch that ain't too close to any house. Weed patches are warm even in coldest weather, and the deer know it."

Giant Ragweed

One spring back there in those boyhood days I decided to explore the soil in one of my favorite weed coves, with the hopes of discovering just why it should be warmer than the surrounding land. My patch consisted mostly of giant ragweeds, or horseweeds, bordered by annual common ragweeds and thistles and mint. Being quite young and unlearned in the science of geology, I at first imagined that Mother Nature was sending the heat from the interior of the earth as a special favor to weed coves -- or to the deer and other wildlife that sought warmth in such coves. But the further I dug into the soil of my cove, the more I came to suspect that the horseweeds themselves were responsible for the warmth. How -- I hadn't the slightest idea then.

It was not until many years later that I learned why the deer could depend on weed coves to supply them with warmth on frigid days. The soil in such a cove is close to

being an ideal organic soil, composed mostly of plant materials in various stages of decay. And since the bacteria that are largely responsible for transforming the weeds into humus are very active and persistent workers when conditions are favorable for them, as conditions are in a virgin weed cove, a great amount of heat is being continuously generated. In such situations the bacteria keep up their work to a degree, even in winter. This heat is the heat of decay. The woman had discovered this heat in her weed patch, and by using weed ashes on her vegetable plots, she had discovered something else.

Our common weeds, possessing vigorous root systems, go down into the lower soils for a goodly portion of their mineral foods because the minerals which plants require are usually abundant down there. Being strong feeders, the weed roots take up great quantities of the minerals and then bring them up to be stored in the stems and leaves. So, when the weeds were burned on the garden, those minerals were deposited there in the ashes, ready to be taken up easily by the growing vegetables. In this manner -- and in many other ways -- weeds are Nature's *true guardians* of the soil. They are the farmer's friends when he uses them intelligently; often his friends though he fights them.

Generally, the "weeds" in this book are the same old enemies of my boyhood. They were enemies then because I had not yet learned their worth. Grass is not included herein since grass does not improve the soil in the same way as do these deep foraging weeds; the deep-rooted herbaceous dicots. They are annuals usually, though a few biennials and fewer perennials are also reliable soil builders.

Near the top of the list I place pigweeds, two or three strains, and lamb's quarter, both familiar throughout the country in garden and field. Under most conditions these weeds are beneficial to the crop with which they may be growing. The same can be said for some of the nightshades, the ground cherry, and succulent purslane. Even some of the noxious weeds, like the cocklebur and bull nettle, are soil improvers where the individual plants have ample room for full root development. Then there is the goldenrod, an attractive weed that can be used in fiberizing gravelly soils, or loose sandy soils. On slopes where water erosion has done its work, the persistent yard purslane along with a few other creeping weeds will do a good job at starting land comeback.

It is possible that no soil-improving weeds in the United States excel the ragweeds, particularly the common annual rag, because the latter will establish itself in practically all types of soil. The giant ragweed, often called the horseweed, is also valuable but is more selective in its habitats. And not far behind the ragweeds are the sunflower, the milkweed, two or three thistles, the annual wild morning glory, stinging nettles, annual smartweeds, wild lettuce, and several wild legumes, including sweet clover, the latter the aristocrat of all weeds. All of these wild plants have root systems that forage deeply into the soil and can be employed as mother weeds, or as green manures in a rotation. All of them are *soil builders.*

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Weeds -- Guardians of the Soil

by Joseph A. Cocannouer

3. Weeds and the Soil World

TO THOROUGHLY understand what those wild plants listed in the last chapter can do in building and maintaining the fertility of land, one must know a good deal about the surface sheet of our planet that supports vegetation, and which I call the *soil world*. For many it is not easy to grasp the fact that the soil world is the absolute dictator of organic life, and that includes human life.

A farm -- or a nation -- blest with unlimited fertile soil is resting on the strongest possible foundation. A nation of fertile soils has little to fear from within or without; for such land breeds national contentment. No such nation exists today -- not excepting our own America. And one of the major causes for the weakened condition of the food-producing lands in the United States has been the wanton destruction of Nature's soil-building plants; her valuable weeds.

A soil world at its best is made up of many active factors, all working harmoniously to maintain the soil's richness. These many factors make up the soil-fertility chain, every link of which has its own indispensable job to perform. This chain is Nature in constructive manifestation.

And wonderful is that soil world, small though it may be, that has no missing links in its fertility chain! One does occasionally run onto such a soil world, even today; an area of land under cultivation where the soil is palpitating with life. It is not difficult to recognize such dirt, through touch and sight and smell: the mellow feel, the odor of mold such as one gets when digging into the virgin organic earth on an undisturbed forest floor. Such earth is usually black, and filled with tiny pieces of broken sticks and leaves in various stages of decay.

I had reached the period of older boyhood when I first explored to my complete satisfaction a soil world like that. We were digging a well in a field containing soil about as rich as Nature could make it. This land had been under cultivation only a few years, and the soil, formed and established strictly according to Nature's laws, had not

yet been impaired by man.

Three of us were working, but the other two did most of the digging. I was kept busy catching and penning up the interesting bugs and worms we routed out. That soil was so alive I soon had a menagerie. As we drove the circular hole down into the earth, every layer of soil came out clearly. Before long I lost interest in my bug specimens. That dirt had me.

Common Ragweed

At that time I had already attended college some and had done considerable reading about soil and land management in general -- anything I could get hold of, which wasn't much, compared with today -- but that first layer of soil showed up much more than I had ever found in books. It actually seemed to be in constant motion. It was inert as a whole, yet there were so many individual moving agents in it that the entire

surface layer seemed to be shifting about. The surface soil was two-feet deep or thereabouts, and scattered through it and clearly visible were fat earthworms protruding from all parts of the wall -- a sure sign of the soil's richness. Then there were beetles and grubs galore, and millipedes and ants. Other insects were there, too, perpetually on the move, either in earthworm passages or in roadways of their own. It seemed to me that every conceivable size of soil life was in that dirt, from those so small they were almost invisible, up to the large bugs and worms.

And, of course, there was much more in that soil -- much which the boy was not yet able to interpret: the countless millions of bacteria that were playing such a large part in bringing about the normal decay of the organic materials. Valuable molds, too, were certainly there; and minute insects and worms. But all of this had to await later discovery. In those youthful days of adventure and thrilling expectancy, it was still part of the unknown.

To my hands that surface soil was like the softest velvet. Its mellowness was due chiefly to the great abundance of organic matter, of course; to plant materials in many stages of decay, from the threads weaving around and among the soil particles to broken leaves and stems that had been carried into the ground by ants and other insects. Though disturbed, many insects could be seen keeping right on with their work.

But it was in the subsoil where I met my greatest surprises. Since the land was still almost primeval, the well diggers had not expected to encounter a compact region until we had gone down several feet. This field, however, had formerly been a lush meadow that had possessed few weeds to fiberize the lower soil regions. I still remember that original grass area very well -- it had contained *dense* grass. Consequently we ran into a stiff subsoil around three feet below the surface. The lower soil contained very little fiber -- except in two or three spots which were very conspicuous.

After examining, those spots for a few minutes, I put a stop to all well digging. How well I recall that discovery! The men wanted to know if I had found gold, and I assured them that I had. I had discovered deep-diving weeds actually at work. Despite my limited scientific knowledge, it was a simple matter to explain to the men just what those weed roots were doing. The deep-foraging weeds of course had moved in after the land had been brought under cultivation; they were a part of the new landscape.

There were, needless to say, working roots in the surface soil -- crop roots and weed roots, too. There was a crop of milo on the land at the time. Weeds were few and scattered, for in those pioneer days all weeds were outlaws. But these were a few that had escaped the hoe, and those weeds had all the room they needed for perfect root development.

Immediately I saw what the weed roots were doing in that stiff subsoil, I scrambled up the ladder in order to identify the weeds, and then try to find out which root systems were doing the best job. I remember that I found two or three pigweeds, some nightshades, and a cocklebur or two. It seems there were other weeds there, but I can't now recall what they were. However, the foraging roots of all the weeds were so intermingled I wasn't able to make out which were which. Most of the lateral roots, whether pigweeds or nightshades or cockleburs, were reaching deep into the subsoil. I could distinguish the roots of the milo, many of them accompanying the weed roots right down. For the earthworms and bugs too the weeds had enlarged the feeding zone. And, interestingly, in the areas where there were no weed roots functioning there were only a few milo roots working below the surface soil.

That display of Nature at work was more than just a thriller to me, though I could understand only a part of what I had discovered. It was a whole book of rich knowledge. Here were weeds -- three very common weeds -- enlarging the root zone for cultivated plants, and that in land where there was an abundance of food in the surface soil. That was what seemed most amazing to me: those wild plants didn't need to reach down into those lower soils for their food! Even the well diggers could see that much. *Those weeds were feeding deeply because it is natural for many weeds to feed deeply*. I did not need further evidence to convince me once and for all that Sol Benson had been right about that pusley up there in his Kansas cornfield. Weeds could enlarge the feeding zone for a cultivated crop!

Years later I was again standing there on that well ladder -- in memory. With more years of study behind me now, I was reading in the well picture what the boy had not been able to grasp: I could see what those deep-diving roots could do in re-establishing a lost surface soil. I could now see deep-diving weeds as the natural agents of soil construction. I had reached the point where I was thoroughly convinced that, without the soil-improving weed link, the soil world would in time lose its normal balance. And at this much later date -- well, our food-producing soils in the United States are woefully out of balance! We are living on unbalanced food products. I am certain that *correct* weed utilization will go far in re-establishing balance in both situations.

For convenience of study, we usually separate the soil world into two divisions, the surface soil and subsoil, though the demarcation between the two is not always so clear as what we found at the well. The top layer, in which most crops feed, is commonly considered by agriculturists as the whole soil. Such a concept is all right so long as this surface soil is deep, well balanced -- with no links missing from the soil-fertility chain.

It must not be forgotten that an ideal soil is one where there is no gap in the fertility chain. In the surface soil at the well, and in the subsoil where the weeds were operating, fiber was there in abundance and working according to Nature's laws. So was every earthworm, every beetle, down to the tiniest ant. When the laws of Nature

operate without hindrance, as they must to construct a *balanced* soil, the mineral elements are held in the root zone in the organic materials, and then released as the plants need them. Consequently, there is no better evidence that the laws are working efficiently than when there is an abundance of organic matter representing all stages of decay; when the sponge structure is strongly in evidence.

And everyone can learn to be a reliable judge of his own soil. One should form the habit of studying it as one would any other important problem. Look first for the fiber. Pick up a handful of dirt and examine it closely. Fiber must be there to guarantee the sponge structure. The earthworms, healthy and numerous, will also be conspicuous everywhere, as will other worms and insects -- if the fiber content is right. If all these agents are there and healthily at work, your soil world is probably functioning as it should.

But don't be dismayed if you find a stiff clay only, or a soil that for various reasons seems unpromising. Don't be deceived by superficial appearances! Such soils may still be rich in plant-food materials. Those materials are just not in a condition to be absorbed by the plant roots. Give that land a good dose of fiber -- and watch the favorable response you get. Decayed barnyard manure, compost built from manure combined with weeds -- or a few well-directed crops of deep-foraging weeds will in time make things right. To conquer and establish balance in heavy, fiberless soils sometimes calls for a real battle. Give weeds a chance to do the fighting. They won't let you down -- if you direct them.

As in my boyhood weed cove, the organic materials provide heat and food for the earthworms and bacteria, and for all other sorts of soil life that play any part in getting the plant's food materials ready for absorption by the feeding roots. With our surface soils largely gone in so many regions of our country, our chief recourse for re-establishing this surface layer is to reach down into the subsoil and rebuild from that; to put a sponge structure into the stiff clays and loose sands, besides bringing to the surface the food materials hidden there beyond the reach of most cultivated crops. Here is where deep-foraging weeds are able to prove their worth. Any of our deep divers can be made to reach down several feet if they are kept on the job long enough. Not only valuable nitrogen is brought up from those lower soils, but also phosphorus and potassium, two other very essential plant foods. It is also probable that the deeper subsoils contain most of the "trace elements" we are now hearing so much about.

In some soils a hard, practically impervious layer, or hardpan, at times develops between the lower soil region and the surface layer, cutting the subsoil off almost entirely as a feeding zone for even the hardiest plants. In the alkali sections of the west and southwest it is known as alkali hardpan, and ranges all the way from a few inches to several feet in depth. In sections where rain is abundant, the hard layer may occasionally be developed by the farmer himself through plowing the same depth year after year. When, for any reason, the fiber has vanished completely, the soil particles are pushed together into a compact mass.

Many years after my discovery at the well, I made use of that weed lesson in improving an area of alkali land in California. The land had a layer of not overly thick yet impervious hardpan lying between the surface soil and the subsoil. (We did not then have machinery for breaking up hardpan.)

I had made a thorough analysis of the soil below the hardpan, securing many samples with my soil auger, and had found that this lower soil contained only a small percentage of the injurious salts. The soil above the hardpan, on the contrary, was strong with alkali that had risen to the surface a long time back -- before the hardpan had developed to shut off the capillary movement of water upward. This surface soil was too strongly impregnated for practically all cultivated crops, as well as most weeds common in that section. Except during the winter and early spring, when surface evaporation was at its minimum, the surface of the land looked as if it were covered with a light fall of snow. But I was convinced, once the hardpan was penetrated in enough places, those surface salts could be distributed throughout the larger soil zone below. Thus diluted they would not be injurious to crops for, as is often the case in such alkali regions, the lower soil was deep and extraordinarily fertile.

So, with white sweet clover mixed with sour clover and bur clover, together with the weed growth that had somehow survived on the land, we started in to break through the hard layer. The weeds were alfilaria, lupines, poppies, carpetweeds, dandelion -- and a few others that seemed to come from nowhere. Among these were a few that did not have to give up immediately the hot days struck. All weeds except the clovers came up of their own accord.

Rough Pigweed

The first trial crop did not seem to get us anywhere, and the second to a casual observer didn't seem to accomplish any more. But it was the second crop which first revealed that something was happening to the hardpan: a spot of vigorous clover here and there; or a clump of other weeds that continued green beyond the time those weeds on such land normally withered and died. It was natural to conclude that these weeds were feeding below the hardpan. The sweet clover had first broken through, then the other weeds followed close behind, enlarging the crevices with their roots.

Then, by planning our operations to fit in with the best growing seasons, we finally had enough breaks in the hardpan so that the concentration in the surface soil could be taken care of by means of the winter rains assisted by flooding. From then on improvement was easy to see. It took us four years to complete the job, but by the time we were through we had turned what the community had looked upon as a

stretch of permanent wasteland into productive land. I had a report on this land only a few months ago. It is now ranked as some of the best land in that part of the state. And the rebuilding work was done largely with weeds; weeds had revived a soil world that had long been chained by alkali.

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Weeds -- Guardians of the Soil

by Joseph A. Cocannouer

4. The Fertility Chain and Soil Balance

THE fertility chain, as stated in the previous chapter, is that series of factors which Nature employs in maintaining the richness in her primeval prairies and on the forest floor. Some of these fertility factors have already been discussed. Fiber is one link vitally necessary as a source of food and warmth for the other links, the bacteria and insects and worms, each of which performs its own specific tasks. Fiber is also important in the regulation of the soil's moisture, particularly in building up and maintaining a reservoir in the lower soil zones.

The earthworms, the tunnel makers, not only build air passages but add to the soil's fertility through their own manure deposits. Earthworms form a link in the fertility chain the value of which would be hard to measure. A weak earthworm population is a good indication that several things are wrong in the soil world.

Nature's constructive wild plants are the most condemned, yet are among the most valuable of all the fertility links. With their strong root systems these "weeds" reach down into the subsoils, open them up, and fiberize such soils so the other agents of fertility can move down and broaden their fields of operation. Sol Benson and his pusley again! Some of the links of the fertility chain are outside the scope of this book: certain soil-improving molds, for instance. There are many links, no doubt, which have not yet been discovered.

That weed cove which meant so much to me as a boy was very close to an ideal example of a soil-fertility chain with no links missing. I have since studied many rich soils in many parts of the world, but rarely have I encountered a soil where there seemed such a uniformity of action among the several workers or chain links. The horseweeds,, never seriously disturbed during their growing periods, year after year had developed, seeded, then died and passed through the various stages of disintegration and decay until the erstwhile weeds were turned into velvety mold. Here other workers took over; the mellow mold was further processed until it became finally plant-food elements ready to be dissolved in the soil moisture so the feeding

roots could absorb them. As I see it now, that horseweed cove was an exception to some of Nature's universal laws: save for a border around the outside of the cove, the horseweeds were alone masters of the area; there were no unrelated root systems at work in the cove itself.

Even to one unlearned in the technical science pertaining to the fertility chain, it was both thrilling and instructive to handle and study that living soil which the horseweeds had formed without any external assistance other than that given by the sunlight and rain. If the soil at our pioneer well was constantly moving, the soil in the cove was really bouncing with life. Working my hands into the cove soil, I could unmistakably feel the life of the soil itself.

That cove held on in its sheltered spot and continued to build velvety soil until the land on the slope back of the cove had become seriously eroded because of improper farming methods, and the holding vegetation along the brink of the ravine had been destroyed. Then the runoff, no longer with any sponge structure to hold it back and absorb it, swept across the slope and poured into the small canyon. From there it roared on to the creek, carrying the surface soil with it. The cove, now deprived of the seepage which it had previously received from the slope water, gradually succumbed. The horseweeds gave way to more hardy species. Common annual ragweeds and thistles took over -- another law of Nature in manifestation: the blanket of vegetation must not remain broken for long. *Nature abhors barren land*.

Then years later man moved out and the almost ruined slope was handed back to Nature. But when I last visited the slope (I couldn't even recognize the spot where my cove had been) I found a grand awakening. The holding vegetation had come back wonderfully along the edge of the ravine; lush grass was creeping over the field that not long ago was spread with soil-building weeds of many kinds. There was still plenty of evidence that the weeds had first taken over and done some constructive work before the grass could move in.

And there was still going on one of the grandest battles of grass versus weeds that I have yet come across. The prairie grass was well on its way to final victory, but the struggle was still tenacious in spots. Invariably where the ground was still hard and lacking in fiber, the grass was unable to push the weeds out. Scattered through every sizable area of weeds were clumps of bluestem grass -- spots where the weeds had built up the soil to the point where it was suitable for the grass roots. There were areas of common annual ragweeds spotted with many grass clumps. Three or four sunflower spots along two sides of the slope were slowly giving way to the grass as were the ragweeds. The blackeyed Susans seemed to be better fighters than the other weeds, probably because they were fiberizing their soil more slowly.

Of all the operations involved in a successful agriculture, maintaining an unbroken fertility chain in farmlands is decidedly the most important. But the farmer's soil-maintenance problems are quite different from those of Nature. Whereas Nature

in her virgin fields produces and then turns her production back into the soil almost entirely, the farmer produces and harvests, and thus is forced to weaken his soil-fertility chain -- unless he carries on permanently constructive soil-maintenance operations at the same time. Most of our food-producing lands have sunk below their primitive strength because farmers have failed to play fair with Nature. Even where quantity production has held up fairly well, quality of produce, compared with what came from our lands several decades ago, is much lower than what producers and consumers realize. The soil-fertility chain has vital links missing!

Removing substances from the soil in order to support life is of course the aim of agriculture; neglecting to keep, up the fertility chain while doing it is poor farm management. It is invariable law that the farmer must put back quantity and quality into his surface soil for quantity and quality removed. That alone will maintain the soil-fertility chain. Rare is the farmer who does not have at his command the very materials that Nature herself uses in maintaining her primeval fertility, and usually in abundance: animal manures, compost materials, legumes and other green crops -- and deep-diving weeds.

But comes the objection: "Those weeds you're talking about will steal the soil moisture! They'll rob the crops!" To which I agree -- in a measure. If the soil is weak and the rainfall light, all of those deep-rooted annuals with which every farmer has to deal are going to demand their share of the upper moisture and food elements for a while. But a farmer rebuilding weak land should always keep in mind that the important things he is after are to strengthen his surface soil and enlarge his crop's feeding zone. That rich stuff which his deep-foraging pigweeds and lamb's quarter and sunflowers and all of the rest of them can bring to the surface from below, is exactly what he needs in the rebuilding. Those minerals and that nitrogen which the weeds are able to pump up will be worth far more than the support the weeds require while they are developing to the stage where their roots are ready to do the pumping. Thereafter the weeds will get most of their support in the lower soils.

"Yes, but why weeds instead of farm legumes or some other cultivated crop?" Here again is the answer to that one: *because few cultivated crops have root systems that forage extensively through the subsoil -- Nature's cellar storehouse*.

Of course, if there is no subsoil from which to pump materials -- better dispense with the weeds; unless the weeds are grown as a green manure. There is not much one can do in the rebuilding of one's land without some sort of a foundation upon which to build.

In improving land with weeds, every sprig of the weed growth should go back into the soil. When weeds are grown alone as a green manure, or when left thinly distributed through a cultivated crop, they should remain on the field as long as possible, but not until they become dry. The weeds should go under while green, yet be given the maximum time to store up materials that have been gathered in the lower soil zones.

In this way man is able to improve on Nature's excellent practices. In the wild, the weeds normally can go back into the soil only after they have decayed above ground.

It is quite possible to have a complete fertility chain so far as the number of links is concerned, and yet have a soil that is not functioning satisfactorily, though the physical condition may be good. Such a condition may obtain when some of the links in the chain are weak while one or more are overly strong. This results in an unbalanced soil. Occasionally a farmer will throw his soil out of balance by pursuing the wrong course in an effort to strengthen the fertility of his land; by overbuilding one or more links to the neglect of the others.

Several years ago I ran onto a case of this kind while checking California orchards for suitable budwood for the various nurseries. The orchard in question had long been an excellent producer. Then it just gave up without any apparent reason. However, when I visited the orchard it was a picture of health and vigor. But it hadn't been that way a great while, and the orchard's owner assured me he had learned a valuable lesson in soil management through a serious mistake.

What had happened was that this man had been fertilizing heavily with a certain commercial product, and had neglected his *organic* fertilizer. Since he was getting good crops of high-class fruits with his system, he increased his concentrates, hoping to raise his production still more. He had promised himself, he told me, that he would get his legumes going the following spring. He felt that would be soon enough. But Nature follows her own laws, not man's whims. She soon showed this orchardist how the breaking of her soil-fertility laws *doesn't* pay.

One day this man noticed that something was happening to some of his trees. The trees appeared anemic. A branch here and there, he told me; then the whole tree. The trees didn't appear to be actually diseased; just weak and hungry looking, and that right when he was stuffing them with expensive fertilizer.

In less than one season more than half of his trees were affected. All of the trees produced fruit, but only a small percentage of the fruit was marketable. And by the end of the year practically all of the trees were "sick." He sought advice and relief from every available source, but received no encouragement. All he learned was that his orchard was apparently done for and that his only choice was to build him a new orchard -- but not on the same land.

So he finally concluded to pull out his trees, but decided to wait a year before doing it. Not that he had any hope of saving his orchard; only that he believed he could by then give up his trees with greater peace of mind. And he did nothing whatever to his orchard that year except to flood the area occasionally. There was no pruning, no spraying, no cultivating. He turned the orchard over to anything that wanted to grow in it -- which meant a grand array of California weeds.

And those weeds took hold with a vengeance. In places, he said, the weeds grew so tall they almost hid the trees. In early autumn of the second year he happened to notice that the trees along the outer edge, instead of dying completely as they were supposed to do, had done just the opposite. They were now green and healthy looking. And that discovery sent him exploring in his weed jungle. What he found there brought him more and greater surprises. The trees inside the weed patch were thriving even better than those in the outer rows.

It was easy to see what had taken place in this man's orchard: the orchard soil had been thrown completely out of balance through a too-heavy application of the rich mineral fertilizer. The trees were overfed in one direction. They were not getting enough other food to go along with the strong mineral. At the critical moment the weeds had come forward and with their vigorous roots opened up the lower soil so the concentrates could be distributed by the irrigation water throughout the larger soil zone. The weed growth had probably been too dense to permit a large amount of deep diving; but there had been enough fiberization of the subsoil to save the day. Of course, the weeds themselves made use of great quantities of the minerals, but by the time the fruit grower was ready to roll the weeds down and work them into the soil, the soil zone was sufficiently enlarged to prevent further concentration when the decayed plants released their minerals.

When I last saw this orchard it was very much of a weed patch. Weeds were growing with legumes. I do not recall whether or not the legumes had been inoculated, but I do remember that the weeds and legumes were doing wll together. Which is to say, the weeds were being controlled to a certain degree now. "And my fertilizer from now on is going to be legumes combined with weeds," this man assured me -- "and with plenty of emphasis on the weeds!"

In short, in maintaining the soil-fertility chain, or in keeping up soil balance, watch the fertility chain as a whole. Don't emphasize some links to the neglect of others that are just as important. It is actually true that a soil is no stronger than its weakest fertility link. Keeping a balance in the fertility chain is practical agriculture at its best.

Mr. E. G. Cambell, discussing weed values in the magazine of the American Society of Agronomy (February, 1924), makes some terse observations which agree with my own findings as to the natural place of our common weeds in building and maintaining balance in the soil-fertility chain. Mr. Cambell evaluates weeds highly for their ability to pump the nitrogen back to the surface after it has dropped into the lower soil zones beyond the reach of ordinary crops, and their ability to hold this element in reserve. According to this author, heavy growths of summer annuals are especially valuable as nitrogen retainers.

Farmers are familiar with the weeds that spread over their fields after small grains have been harvested: common ragweeds, wild lettuce, thistles, sunflowers, nightshades, etc. Such weeds through the work of their roots actually fertilize the soil for the next crop. This is an excellent illustration of how Nature's soil builders play a

sound part in maintaining soil balance.

Mr. Cambell hands the weeds along the highway and country roads some deserving commendation. Those weeds, he says, are an asset in a community's agriculture rather than a detriment. Mostly without the farmer's knowledge, the roadside weeds check erosion in numerous ways and thus save many acres that would otherwise be lost. And certainly they protect the highway itself -- but not when they are slaughtered the way they are in so many places.

Any farmer who wishes to learn the true habits of the weeds in his locality can find no better source of information than those strips and clumps of wild plants that border most roads. There he will find growing most of our soil improvers. Using his shovel when the ground is soaked and the weeds near full size, he can discover a great deal about the root growth of the annuals he has in his fields. Usually the roadside will reveal how these weeds grow under adverse conditions, and in what types of soil they seem to do best: whether in the tight clays, the sands, or the coarse gravels.

It will be worthwhile to learn how the weeds thrive in the spots that are very much like that field or two on the farm that may be badly in need of improvement. The roadside patch will show at what season of the year any particular weed makes its best growt -- -and when and how it produces its seed, in case a harvest of seed may be desired. Mr. Cambell emphasizes the value of weeds that grow during the winter. Winter weeds are usually deep feeders. Such weeds should be encouraged for they do their land improving during the off season for cultivated crops.

But -- *weeds are not mushroom soil builders*. Keep mind that weeds, aside from pumping much valuable material from the lower soils up to the surface, also do very constructive work by fiberizing the lower soils. Often it may require several weed crops before any noticeable benefit appears in the cultivated crop above ground. But in due course the weeds, if kept on the job, will re-establish land balance.

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Weeds -- Guardians of the Soil

by Joseph A. Cocannouer

5. Plant Roots

ONCE while sitting in on an agronomy class during iny first year at college (I wasn't permitted to enroll in tbe course owing to my not having the prerequisites), thc professor announced what he considered a new and very important discovery. "Imagine the young roots of alfalfa making ten times the growth of the stem during the first three weeks! Why, it's almost unbelievable -- "

Forgetting that I was merely a visitor, I bobbed up from my seat in the back of the room -- "It's that way with weeds, Professor! " I chirpcd right out. "The roots of most all weeds grow lots faster than the tops -- "

All eyes turned suddenly upon me -- and I wilted back onto my bench. The professor went on with his discussion of alfalfa seedlings, ignoring the profound wisdom I had so generously offered to his class.

But it struck me as being nigh to shocking for a teacher of agriculture just then to be discovering that the roots of plants grew more rapidly than the above-ground parts. I didn't know a thing about alfalfa at that time, but I was plenty familiar with the root habits and stem habits of sunflowers and lamb's quarter and cockleburs and a passel of other weeds. On our own farm I think we unconsciously meant weed roots whenever we thought of weed injury to our crops. The vegetative parts were royally disliked, needless to say, but largely because the green parts indicated what was taking place down in the soil. The various leaf changes meant specific root changes; appearance of flowering buds and later of flowers told us what kind of growth the roots were making. Every farm boy knew that, if the weeds were growing thick, like a jungle, most of the roots were feeding close to the surface of the ground. But if each weed had ample room for unrestricted growth, by the time the plants were a foot tall the roots were foraging far from home.

Those gluttonous roots! Mother could see them only as vile enemies of her potatoes and cabbages and sugar corn that must be taken from the soil completely. When we

had not been able to eradicate the thistles and pigweeds. and sunflowers and such before they became large, we had to get out and pull the things on rainy days. We had to carry the weeds completely off the field, too, or if the field was large, we grudgingly allowed sufficient space for building weed piles. We never thought of employing the pulled weeds as a mulch on top of the ground where they could have helped to conserve moisture and keep the soil cool. We wouldn't even give the weeds a chance to decay and go back into the soil as fertilizer.

Luckily for our soil, only a small fraction of the weed roots could be extracted, even when the ground was slushy. Since weed eradication could receive only its allotted time, the weeds often passed beyond the pulling stage before we got round to them. Then they had to be cornknifed. "Can't go fishin' today -- got to cut poison nightshades and sunflowers outa our corn!"

"Mean yer knifin' 'em already?"

"Shore! Nightshades got buds!"

"Gee! Then that means their roots are powerful. Break too many cornroots to pull 'em -- "

"And Pap says it'll take me and Jim three, four days -- "

Lamb's Quarter

The redroot pigweed intrigued me particularly in those days. Not that I had any special admiration for the thing, but because on a plant growing alone the vegetative development used to be such a perfect indicator of what the roots were doing at every stage of growth. The black and shiny seeds of the redroot, produced by the thousands by every full-grown plant, have marvelous vitality. The husky red rootlets go galloping down into the ground immediately the seed germinates, and the subsequent roots don't stop foraging as long as there is life in the stem. At first this pigweed stem is delicate and innocent looking, but in a short time it takes on the rough, don't-touch-me appearance. By the time the greenish flower clusters appear in every branch axle, which is usually before the plant is a foot tall, the lateral roots, which spring from the strong taproot, have penetrated long distances in every direction. At this stage most of the feeder roots are diving into the subsoil for their food and water.

And by the time the main stalk with its rough flowering parts reaches two feet or so, an even larger proportion of the feeding roots are working in the lower soils. At this period, even if the soil is muddy, the weeds are so well anchored they are difficult to pull up. And what those weeds in all such situations are gathering up to be stored in the roots and stems and leaves! Nitrogen and phosphorus and potash and almost everything else needed in the plant-food line. Nature's soil improvers -- and we were treating them all the time as some of our worst enemies.

And what is true of the pigweed is also true of its usual companions: the sunflower, lamb's quarter, sow thistle, ragweed, ground cherry -- even the trifling cocklebur.

In classifying plant roots, botanists list first the strong or anchorage roots that hold the plant in the ground against the pull of the elements. These roots also support the plant so it can get the necessary sunlight, for the sun is the power plant that supplies the energy for the leaf laboratories. The anchorage roots have to be rigid, yet in a measure flexible to stand the severe strain that may be placed upon them. After the anchorage roots come the great mass of roots known as the food hunters. These roots range in size from slender threads to roots many inches in diameter. Normally the food-hunting roots prowl through all parts of the soil world.

A few domesticated crops, and practically all herbaceous wild plants that I have listed as valuable weeds, appear to have two distinct groups of feeding roots: those which secure their food entirely in the surface soil, seldom wandering far from the base of the mother plant, and which usually are vigorous only during early growth; and those rovers that go far for food and water. I have found these two types of roots on desert plants in Africa, on many tropical plants, and on temperate-zone wild annuals. On some common weeds, like the pigweed, ragweed, and sunflower, the two types of roots are at times very noticeable.

I had my first introduction to these two types of feeder roots when we were digging the well. Practically all weeds do have plenty of roots that feed in the surface soil, and until the deep feeders are well established in the lower soils the former will get their share of the food materials near the surface of the ground. Once the deep feeders are settled to their task of feeding down below, however, most of their feeding is done down there -- unless the subsoil is extremely weak. From then on, provided the weeds don't crowd each other, they will more than pay back to the cultivated crop all they robbed it of.

The reason those common wild plants known as field and garden weeds are persistently classed as pests is because they are judged entirely by what the surface-feeding roots *appear* to be doing. No thought is given to those deep feeders which are improving the soil by fiberizing it and thus enlarging the feeding zone for the cultivated crop -- to say nothing about those large quantities of rich food materials which they pump up to the surface from the lower regions.

The rover roots generally (except in grasslike plants) cannot themselves take up the food materials once they have reached them. This task of absorption must be carried on by the delicate, very tiny root hairs which protrude mostly from the smallest rover roots. These absorbing rootlets are very short-lived, and are developed right where they are to do their work. They have no openings whatever, but can absorb food-substances when the latter are dissolved in water. By providing no openings into the root hairs, Nature guards the plant against many undesirable substances, probably to the ultimate great benefit of the human race.

Since the root hairs are so frail, their ability to function efficiently depends on the condition of the soil world. Actually, it is possible for a soil to be rich in plant-food elements, yet give low production because some of the factors which encourage the growth of root hairs are lacking. The condition most likely to prevent the development of the short-lived feeding rootlets is lack of suitable soil fiber, which means a soil that is either too loose or too compact. Neither can feeding roots grow efficiently in a soil that is too wet, too dry, or too cold. In other words, a soil may be declared strong on chemical analysis, yet give low production because of improper physical condition. The soil may be locked so far as the feeding roots are concerned.

Where farmland is giving poor returns, in the great majority of cases it is the physical condition that needs most attention. The soil probably has all the minerals it needs, if not in the surface soil, then stored in the subsoil. A few lush crops of deep-rooted weeds, grown as a link in a rotation scheme, or as properly regulated companion crops, will go a long way toward righting the situation.

Before the root hairs can absorb any of the food substances, those substances must be dissolved in the soil water, and the water must be in the form of a thin film which surrounds or clings to the particles or granules of soil. Except in water plants, very little water can be taken in by the rootlets save from this delicate film. The root hair coils partially around the particle of soil which contains the food materials and which is enveloped in the water film, then "draws" into itself the film containing the materials in solution. The water stream then moves up through the roots and stems, climbing even to the tops of the tallest trees. Starting in the soil-world laboratory, going through many intricate processes while yet in the soil world and after leaving it, finally ending up in the leaf factory, this stream becomes the greatest watercourse in our Nature world. When the leaves have completed their part of the entire operation, the result is a finished food product without which there could be no human life -- nor any other life.

When no factors are missing in the soil-world laboratory, there is a reserve supply of food and water in the lower soil zones -- in the fiberized subsoil -- that can be called upon during periods of drought, or when the surface soil is being too heavily mined. But that condition obtains normally only when all major links in the fertility chain are functioning. Such soils will produce crops with far less water than will a soil that is out of balance. In a poor soil it takes a lot of water film to meet the meager food

requirements of the plant. Crops dry up quickly on poor land, not only because they need moisture, but because, having been deprived of food, they lack the power of resistance.

And now the question: what is it about weeds that makes it possible for them to do all this soil-improving work not possible with most farm crops? If weeds are directed, or even if given a fair chance to go it alone, they will establish that reserve referred to above, through the fiberizing of the subsoil.

Most wild plants have been forced, through their struggle for existence across the ages, to develop roots which will forage deeply for food and water under adverse conditions. The larger portion of domesticated crops, by virtue of their having been more or less pampered by man, have lost most of the soil-diving ability possessed by their wild ancestors -- if they happened to come from wild ancestors. What has happened is that most crops have received their improvement above ground; their root systems have grown weaker with civilization. The root vegetables are exceptions, of course. As a rule crop roots are not fighters in soils where it requires a real struggle to make a go of it.

Aside from being husky divers, many wild plants have the ability to "eat" their way through compact soils because of special dissolving substances which they exude from their roots. The dissolving materials soften hard obstructions and thus aid root passage. But, so far as I have been able to discover, these dissolving materials are not harmful to the weed roots or to the roots of crops that may be growing with the weeds. Sweet clover is an excellent example of a weed that eats its way through hard soil. Just what weeds put out this dissolving substance is not definitely known so far as I am aware. Sunflowers and ragweeds I think do, and probably cockleburs. The chances are that all deep-diving weeds have some ability to eat their way through stiff soils.

And there always seems to be room in the weed-root tunnels for the roots of cultivated crops. I have found the roots of some garden vegetables following the roots of pigweeds and lamb's quarter down into the subsoil, though ordinarily these same vegetables are not deep feeders. Beans and sweet corn and onions like to send their feeders into the lower soils along with those of the weeds. In a clean onion field the onions feed very close to the surface. Many normally shallow-feeding crops will forage deeply in a soil if the soil conditions are made right for them.

It is hard to make farmers or gardeners see that the weed roots are not the water robbers they appear to be. If pusley or pigweeds or nightshades or ragweeds or what not are found in a garden or field when a drought strikes, the wild plants are blamed if the crop dries up. The fact is (unless the weed crop is very heavy), the weeds will not only feed in the lower soil zones themselves -- unless there is no subsoil -- but will also be the cause of an upward movement of capillary water *along the outside of their roots*. This will happen even if there is only a small amount of water stored below.

The upward-moving moisture becomes immediately available to the crop roots that are feeding in the surface soil. Though the crop may dry up in the end, the chances are that the weeds prolonged its life considerably.

To repeat: a crop growing in a weedy field, provided the weed crop is reasonably thin, will go through droughts better than crops grown on clean land. Moisture comes up along the outside of the weed roots; many crop roots accompany the weed roots into the lower soils and thus secure extra moisture in that manner; and the weed growth checks evaporation from the surface soil.

Cocklebur

Concerning weed roots as good soil fiberizers, a Kansas farmer reported to me what he considered a very important discovery on his part. He said he had several acres of extremely tight land with which he had been struggling for years. Finally, in disgust, he abandoned the fight -- turned the land over to cockleburs. Or rather, he turned a part of the field over to the burs, while he continued to farm the remainder.

"And you ought to see what the cockleburs have done to that abandoned part!" his

neighbor told me. The farmer himself said he was waiting anxiously for the burs to take over the rest of the field as they had done on the first part. He had a mess of cockleburs, all right, on the abandoned area -- and last year made a good profit from corn produced with the help of the cockleburs. The cockleburs, with their deep-forage roots, opened up the tight land and fiberized it. The weeds, not being too thick, had done a good job.

One of Nature's valuable laws is that two unrelated root systems do better when growing together than when either is growing alone. There are, of course, occasional exceptions to this. The wild growth in forest or meadow shows the law wonderfully in operation. Nature keeps her soils in complete balance largely in this manner. Wherever one species of plant occupies an area alone, it will usually not long survive. My boyhood weed cove was an exception. Ordinarily the single species gives way to a mixed growth. And this mixed growth is likely to hold its own for a long stretch of years. This is Nature's system of crop rotation. But she needs to do much less rotating when the roots are dissimilar.

In maintaining her green carpet on the earth, Nature wastes nothing. For instance, some plants secrete strong substances from their roots (substances which are apparently not useful in the dissolving processes) which, if left in the soil, will prove injurious to some unrelated plants as well as to the plants exuding the materials. But many unrelated plants find these substances in no way harmful when contacted by their feeding roots. Actually, the substances may be taken up by these plants as food. Or if not as food, certainly with no ill effects. A few members of the sorghum family leave in the soil considerable toxic material. In the irrigated sections of the west it often takes two or three cropping seasons to eradicate this poison. However, when legumes are grown with the sorghum, the land rarely registers any lowering of production during the following season. The legumes seem to take care of the poison left by the sorghum.

And weeds -- every one of our soil improvers -- will also take care of those toxic materials. I remember a field of grain sorghum that was given little or no cultivation, with the result that the weed crop was more conspicuous than the sorghum, though there was an excellent crop of sorghum growing among the weeds. The land produced heavily the following year, a crop unrelated to sorghum, but an adjoining field that had been kept free from weeds on the same type of land did not do so well. The weeds strengthened the land and took care of the sorghum secretions at the same time.

Several years ago a friend told me about a case of tree planting which indicated how unrelated trees, when employed together in building a farm grove, can mean longer life for the grove than when only one species is planted on the land. It seemed that an "impractical" farmer had moved into the community from the city. In the eyes of the old settlers, this man did everything incorrectly -- and was too contrary to accept advice even when offered to him gratis.

One of this city man's worst sins of commission was that he planted a timber lot,

using several types of trees carefully interspersed. I don't remember just what the trees were, other than that they were all hardwoods. The man who gave me the report said he was a boy when the grove was started. He was now past middle age, and the grove of mixed trees was still holding on well in his old neighborhood. All of the other groves had vanished almost completely. It would seem that the mixed grove survived because of the diversified root systems which had been able to work constructively together.

Now to summarize the values of deep-diving weed roots: (1) these roots are persistent explorers in a rich world which is to a large degree unknown to domestic crops -- *until the weed roots build highways leading into it.* Thereafter the crops are provided with a more extensive feeding zone. (2) The weed roots pump those "lost" food materials back to the surface soil; (3) the weed roots fiberize the subsoils and (4) help to build a storage reservoir down there for water; water moves up along the outside of the weed roots -- up to the surface soil and the thirsty crop roots which feed in the surface layer. That is why a crop on "controlled" weedy land can go through a drought better than a clean crop on similar land.

And yet we slaughter them! We destroy with poison the natural source of the essential soil fiber, and with our food-producing soils screaming for fiber and the food elements which the fiber carries with it. Aside from destroying the weeds, we also pour poison into the soil-world machinery. The claim by some spray promoters that the poisons, after the spray has been applied, will vanish into the air, certainly will not hold water in all situations, and probably not in many. A goodly portion of the poison will be in or on the bodies of the dead weeds, and cannot fail ultimately to reach the soil -- unless every sprig of the weeds is removed from the land. Even then it will not be possible to eradicate all of the poison. Perhaps a single spraying will do little or no harm; but the persistent use of "weed chemicals" is pretty sure to bring about a condition which may prove difficult to overcome once the soil has taken up any quantity of it beyond a still unknown danger point.

However, the greatest injury to result from the continuous use of weed sprays on cultivated land will in all likelihood prove to be the deprivation of the lower soils of their fiber content which some of our weeds are particularly capable of putting down there. Without this fiber the soil particles settle close together -- into a *compact* condition. Ultimately the heavier soils become so "run together" that the upward movement of capillary water is almost entirely cut off. And when this condition obtains, though the surface layer may be amply fertile, the soil world as a whole is in danger of being thrown out of balance, because it is not a completely normal feeding zone for most plants. And, of course, in such cases there is no emergency reservoir to call upon; growth even of crop roots is restricted; and that valuable storehouse of minerals and nitrogen in the subsoil remains locked up.

But even so, there *are* situations where weed chemicals would seem to have a constructive place. There are times, you know, when reputable physicians prescribe

strychnine as a medicine. Using chemicals in eradicating poison ivy may well be compared with the doctor and his strychnine. Here is a place for it! And I can see cases where "noxious weeds" may need to receive the same treatment -- as an emergency. On the other hand, there is no sense in slaughtering the mockingbirds and cardinals and song sparrows and other songbirds -- simply because the crows pull up the young corn.

Annual Black Nightshade

Occasionally a report comes in to me that some chemical weed killers actually enrich the soil; enhance crop production directly. Such is entirely possible, for it is not difficult to stimulate soil into *false* production. A few commercial fertilizers will do that, and weed sprays could do it if enough of the spray reached the soil. But *stimulation is not fertilization.*

Then again I have had reports to the effect that some crops on sprayed land did not seem to react favorably to the spray, while others did not appear to be affected either way. What, some wish to know, is the reason for this? Also, why do some crops seem to do very well on sprayed land during a part of their growing season, and do poorly at other periods of their growth? "They don't act that way when we cut the weeds -- "

As I have stated elsewhere in this book, there is much about the workings of the soil world that we do not yet understand. It goes without saying that we still have much to learn about the effects of many of our chemical compounds on cultivated soils. But there is one thing that we do know with certainty: anything that interferes with the constructive laws of Nature down there in the soil world is going to stir up trouble. Whether the poison goes down into the soil through the weed roots, whether it is carried into the soil through the dead bodies of the weeds when the latter decay, or whether the stuff is sprayed onto the soil directly -- there is bound to be some interference with the soil-world machinery. And it is entirely possible that a very small amount of *some* poisons will create far more havoc than is at present suspected of them.

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Weeds -- Guardians of the Soil

by Joseph A. Cocannouer

6. Weeds as Mother Crops

COMPANIONING weeds with farm or garden crops *constructively* will probably be the last phase of weed utilization to be accepted by American tillers of the soil. However, right now there are many practical farmers in this country who are employing "weeds" in this manner -- and successfully. A farmer from one of the most progressive states writes me that he has for several years used "mother weeds" in some of his crops, much to his advantage. He considers these weeds as particularly good crop insurance. Furthermore, this man has found that his mother weeds without exception are *conservers of soil moisture rather than robbers.*

Mr. F. C. King, noted agriculturist in England and author of the excellent book *Gardening With Compost* (Faber & Faber), also considers the weed link in the soil-fertility chain as very essential to successful crop production. A few of Mr. King's pertinent declarations about weeds are worth noting here: "A right cultivation of weeds, therefore, will do much to promote soil fertility -- Raise the quality of a weed crop in a garden and quality in the vegetable crop will be a foregone conclusion, FOR THE TWO ARE INTERDEPENDENT -- Seed saved from the best plants (weeds) should be sown on land which is carrying a poor weed crop -- It is my rule never to deprive the soil of weeds for longer than is absolutely necessary -- During the course of the growing season there is room for both crop and weeds -- *I have never found that* CONTROLLED *weeds interfere with the crop* -- "

Controlled weeds! Farmers and gardeners should not get the idea that companioning weeds with crops indicates a careless system of farming. It is true that with some crops the weeds can be permitted to go their own way; allowed to grow how and where they please, and still they will do constructive work. But as a general practice the weeds must be controlled for consistently beneficial results. They should be thinned so there is no crowding in garden or field of the domestic crop, and no crowding of the mother weeds themselves. It is the vigorous root system of the weed that does the valuable work, and those roots must have room to develop. That means weed spacing of one, two, or more feet, depending upon the type of soil and the kind

of cultivated crop, as well as upon the weeds employed as the companions. With garden crops, weed spacing is even more important than it is with field crops, because vegetables as a rule are more sensitive. Extra work? Surely! To rebuild land, as Nature does, spells work.

Not long ago I inspected an excellent field of corn where the wild annual morning-glories had moved into a goodly portion of the field -- and those vines were *not* being controlled. The farmer told me that he had always had some morning-glories, but this was the first year they had come up like a jungle. "My very best corn is out there in those vines, too! See the ears?"

That the vines hadn't harmed this man's corn, the ears were ample evidence. Later he showed me a section of the same field that contained no morning-glories. The corn there was also good, but not equal to that where the vines were growing. We examined the soil that was weed free, and also that on the vine-covered area. The farmer was certain he could see a difference between the two soils -- and a shovel revealed the cause. The roots of the morning-glories were worming their way through the ground, many of them pushing far down into the lower regions.

I asked him, "Do you really think those vines are helping your corn, or is it just a case of the corn making a good go of it in spite of the weeds? "

He hesitated a moment. "Well, I'll give you the same answer my neighbor gave me. I don't think there is a bit of doubt about wild morning-glories being helpful to corn! How -- I won't try to answer that -- "

One of the most shocking sights near our new home in the Cherokee Strip was the weed patches near the main camp of the Pawnees from which the squaws harvested excellent com and pumpkins. To me it didn't make sense for weedy fields like those to be turning off such good crops. My first thought was -- only Indians could farm like that and grow anything to harvest.

It was not long after my arrival in the Strip that my hunter-naturalist friend told me about a wise old Indian who, he said, was different from any Indian I had ever read about. John Brown (according to Louie Bean, the hunter, John preferred to be known by his white-man name) had profound respect for all wild things, because wild things were all good and necessary for the Indian's existence and happiness. And since what the white man called "weeds" were useful both for healing and for food, those wild plants could not possibly do harm, even when growing with the corn and pumpkins and beans.

Of course, I was keenly interested in what Louie told me about Indian John, but after Louie had arranged for me to visit him, I wasn't sure I wished to go, especially alone. Louie insisted that I go alone, for John mustn't get the idea that I was afraid of him. So at last alone I went, over to John Brown's lodge on Salt Creek. And Indian John,

much to my relief, put me at my ease immediately. Not that he said much to me; he just acted friendly. He grunted me a greeting, Indianlike, then, sitting crosslegged, he smoked his long pipe and acted as if he expected me to do all the talking. And to save me I couldn't think of a single question I had worked out in advance to ask him.

But after a few agonizing minutes my nervousness vanished. My store of questions came flooding back -- and I started hurling them at John. "Why is it, John?" I said, "that the Indians never cut any of the weeds out of their fields? Is it just 'cause Indians are lazy, or what?"

John was quick enough with his words then. It's a wonder he didn't scalp me on the spot. "Indian not lazy! " he wanted me to know. "Indian let weeds grow in field because Indian eat weeds!"

"You mean the squaws let all of the weeds grow so they can have plenty to cook for greens?"

John frowned a bit at that. Apparently the word "greens" was new to him. "Indians eat plenty green weeds," he said presently; "all same eat corn, pumpkin, fat dog."

"But there are acres of weeds outside the fields -- more'n all the Pawnees could ever eat!" I reminded him. "Are the weeds that grow with the corn supposed to be better?"

It was then that Indian John really opened up. The weeds in the field were superior as food weeds, just the same as any crop is better when it is given a bit of attention during the growing period. In the field soil the weeds grew fast, he said, and produced an abundance of tender leaves and stems, whereas the wild weeds became tough soon after they had made a little growth. To make sure that their weeds would grow as they wished them to grow, the squaws thinned their weeds a little. This gave the weeds a chance to grow larger roots, and when weeds had large roots they were able to go down into the soil for water, which in turn kept them green and succulent longer.

Whenever the squaws cultivated their corn, which was seldom, they of course gave the same cultivation to the food weeds and pumpkins. And by then my head was buzzing -- I couldn't accept the idea of anybody *cultivating* weeds. Sol Benson never thought of cultivating his pusley, other than incidentally. And before my senses straightened out, John hit me with another bombshell: if you could grow corn and beans and pumpkins and weeds on the same piece of land at the same time, with all of those crops getting along well together and producing well, why go to the trouble of working the separate fields? And my dizzy brain could only echo -- Indians *are* nutty!

In answer to my question as to whether he had really meant that the weeds were not harmful to the corn and pumpkins, John came back even more decisively. The corn and pumpkins were not harmed by the weeds that the Indians grew as food weeds, which, as I recall, generally meant two strains of pigweeds, lamb's quarter, sunflowers

(for their seed), a variety of wild lettuce, purslane, and milkweeds. John had all his life seen the harvests from clean fields such as white men always had near the agency, and he had been brought up near weedy fields. When the weeds grew the Indian way the weeds never reduced the production of the planted crop. Indeed, Indian John said he had come to the conclusion that the weeds helped to produce *more* corn and pumpkins in some of the fields with which he was familiar.

When John went so far as to insist that weeds were helpful to the planted crop, I immediately thought of Sol Benson and the pusley in his corn. By now it wasn't so difficult for me to accept weeds as not being harmful to the crop, provided the weeds were not growing overly thick. But to have John declare that *all* weeds were beneficial to the planted crop with which they were growing -- well, that was a bit too rich for me at that stage of my weed schooling.

Many years after that important weed lesson with Indian John -- plus several other lessons I had from him -- I made a survey in Mexico of the mountain Indian's agriculture. I was at that time particularly interested in the tillage practices which those Indians employed on their "hanging farms" where one could fall out of a field and with considerable ease break one's neck. Yet on those almost perpendicular farms I found the Indians growing crops with unbelievable efficiency. I wanted to know how they could do it and still keep their land from sliding off the mountain.

It was while I was seeking this information that I came upon a very steep farm which abruptly brought Indian John and the Pawnee weed patches back to memory. Though the Mexican as a rule practices clean cultivation, this farm had a rich crop of weeds. I was more than mildly surprised at this breaking of unbreakable rules, for the early Spanish padres taught the Mexican Indians their first "scientific" agriculture, which called for fields as free from weeds as a cathedral floor. Now here was an apparently successful farm where the weeds were more in evidence than the domestic crops -- though the domestic crops were there, several types of them, growing luxuriantly among the weeds. This Mexican Indian was not onlv growing weeds with his crops; quite clearly he was spacing his weeds and *pampering* them.

I was able to speak enough Spanish to ask questions. So I learned from this Indian farmer that he had discovered through trial that weeds, when they produced strong roots that spread through the ground, were better anchorages for his soil than were his corn or beans or squashes. He was more scientific than Indian John, since the Mexican controlled his weeds very definitely in order to accomplish his purpose. The large weeds, aside from being soil preservers, also served as mother weeds for his vegetables, though he wasn't quite sure just *how* they helped his pimientos and calabasas.

In companioning weeds with his growing crops, whether in the garden or in the larger field, the farmer or gardener should be concerned first with what the weeds will do to his immediate crop; second, he should be interested mostly in what they can do

toward improving his land. If his land is already fairly productive, he will probably be more concerned with the immediate effect of the weeds on his growing crop. In this situation, his problem will be to use the weeds in a way that will help his soil and his growing crop, too. But if his soil is seriously eroded or otherwise depleted, he should take a long-range view of his problem. He should be chiefly interested in the *permanent* improvement of his land, even if the weeds would seem to be temporarily injurious. What he loses through this severe soil-building period will be more than paid back later.

How not to produce an oversupply of weed seed when the weeds are used as mothers with row crops is a problem that every farmer will have to work out for himself. Some may choose to go through the field or garden and behead most of the vigorous weeds before the seeds develop. With annual weeds it is possible to destroy a large percentage of the seedlings soon after the seeds germinate in the spring, through surface stirring before the domestic crop is planted, or during early cultivation. No matter what system is employed, unless the soil is extremely poor there will still be enough weeds to cover the land correctly when the weeds are put to work as a mother crop.

Weed farming cannot be learned completely from a book. All that a book can do is to offer the basic principles. Anyone who enjoys working with soil and plants is in a position to make many interesting discoveries anent weed values if he desires to do so. He can prove that those very wild plants he has looked upon as annoyances can be made to serve him as helpers in many ways. And the first thing he should do, if he hasn't already done it, is to become intimately acquainted with his weeds -- *where* they grow normally and exactly *how* they grow.

Milkweed

I am partial to the redroot pigweed, because this weed can be made to do a good job on most soils. On heavy soils, if the weeds are not crowded, it will loosen the soil for root crops such as carrots, radishes, beets, etc. And potatoes -- a husky pigweed every two feet in the row may often increase the production of the potatoes, or in very heavy soil be the main factor in making a crop possible at all. Weeds in a potato field will enhance the keeping qualities of the potatoes. Pigweeds and tomatoes, peppers, eggplants, all get along well together. An excellent gardener once told me she wouldn't think of having a tomato garden without a smattering of pigweeds growing in it. The weeds improved the quality of her tomatoes and protected the plants from insect pests.

If the gardener hasn't any pigweeds to employ as mother weeds for his vegetables, many other deep-rooted weeds will do as well: the sow thistle, lamb's quarter, annual nightshade, ground cherry, ragweed, and many others. I have seen situations where the bull thistle was boring down into the stiff subsoil better than the neighboring pigweeds -- and the vegetables showed that they appreciated their thistle mother. If

one wishes to grow sweet potatoes, but has only stiff soil in which to grow them (sweet potatoes are especially partial to sandy soils), one will find almost all members of our weed family reliable helpers if they are permitted to grow on the ridges. The strong roots of the weeds expand and open the soil in the ridges so that the potatoes can grow large without becoming woody.

In the sandier spots there are likely to be annual nightshades offering their service, or perhaps some goldenrod. These weeds are good soil improvers, aside from their beauty. Lamb's quarter is a good weed in many places if given ample room. This weed usually needs to be topped so that it won't grow tall. Annual ragweeds, one of the best for most soil-improving purposes, are not so well adapted to vegetable conditions as are several others, since the rag's root system is not overly large. This weed serves best in a rotation where the entire crop is weeds. Sunflowers also do not serve well as mothers in a garden, owing to their height. But both ragweeds and sunflowers scattered through farm crops do a lot of good. I have no doubt that sunflowers, growing in a Kansas cornfield as companions of the corn, have across the years meant many an extra bushel to the farmer who could never get round to cut them out.

The ground cherry is an especially valuable garden weed. It is a good-natured annual, and a fair diver, which can prove helpful in more than one way. It not only brings up food from the deep soils and does some excellent fiberizing at the same time, but it supplies fine shade for the ground during the period when the sun is particularly scorching. And aside from all this, the fruit of the ground cherry makes excellent preserves and pies. Then there is wild lettuce, a winter annual in many places. And here I wish especially to emphasize the value of the sow thistle, a member of the lettuce family. These weeds are good feeders in the lower soils, and when a gardener is fortunate enough to have a good crop of them to turn back into the soil, he is applying the very best fertilizer to his land.

I have often heard gardeners complain about not being able to grow this or that kind of vegetable, though every possible effort was made to do so. Mothering such vegetables with the right kinds of weeds will often solve the difficulty. Root crops, like beets, carrots, etc., need a deep, friable root zone with food materials easily available. Mother weeds will loosen the soil so the roots can enlarge easily. Root crops are usually hardy, but to be highly nutritious and savory, roots must not be forced to fight a compact soil. With leaf crops, or any other vegetables that don't seem to be responding as they should, an intermingling of the weed roots with the vegetable roots will often perk up the vegetables amazingly.

Once I heard from an observing farmer: "Even if weeds did all the harm that most people seem to think they do, they'd still have to be given credit for doing a lot of good." And he added, "Weeds stop the rain and keep it from pounding the dirt into cement. Stopping rain in that way is mighty important. With weeds in a field where a crop is growing, the rain first hits the green stuff, then trickles down to the soil. By reaching the dirt in that way it soaks in without sealing up the top of the ground and

then running off."

How right he was! Have you ever watched rain pouring down on land that has been newly plowed? The beating drops soon cement the surface of the soil by driving the particles together, unless the land is rich in fiber. With the surface of the soil in this condition the water cannot soak in readily and consequently must run off or form puddles, and every drop of water that leaves the land carries soil with it.

And here's another weed value that farmers and gardeners should not forget: unless there is a crop of some kind on the land continuously to take up the food materials that are under continuous preparation by the soil-world agents, much of this food will be lost through washing or leaching, or will disappear in some other manner. No agents can excel deep-rooted weeds for gathering up and storing this rich food. When the weeds are turned under and later decay, the food substances are released into the surface soil for the oncoming crop. Bare land spells wastefulness.

Weeds have a place in the flowerbed, too, growing as companions of the flowering plants. As in growing quality vegetables, the flower gardener should center her interest on the feeding zone of her flowers. I once knew an old lady who was famous for her old-fashioned flowers: zinnias, marigolds, peonies, pansies -- all the varieties that our grandmothers used to grow. Granny's beds were always a riot of color, and she enjoyed telling folks that she produced her flowers with the help of lamb's quarter. I recall that the big weeds stood three or four feet apart, and usually were larger than the flowering plants. But the weeds did not detract from the beauty of the beds. The weeds, too, seemed to be bearing an assortment of bloom. People used to go to Granny for flowers for special occasions -- the gorgeous flowers that were produced with the help of weeds.

Rose bushes are often baffling. Many kinds of roses grow satisfactorily and blossom without much care, but even the most hardy of roses respond to a bit of special treatment -- and weeds stand ready to help. Rose growers know that the most difficult time is the period of very hot weather in summer. In some sections many of the choicest varieties do not weather hot days without injury, though water for irrigation may be ample.

In such situations, carpeting the ground around the rose plants with weeds may serve a good purpose. Encourage any low-growing weeds that happen to be available, to grow around and close to the rose plants, and water copiously if possible so as to keep the weeds green. Plant or transplant the weeds if necessary -- but don't permit grass to grow as a carpet. Grass feeds differently from the weeds. Only the weed roots work down into the soil and intermingle advantageously with the rose roots. Here we have unrelated root systems working together to the benefit of both. If water is not available for irrigation, only very hardy weeds should be used -- spreading spurge, for instance -- and these should be thinned so as to leave on the ground only enough to cover it well. Even though the weeds may rob the roses of some moisture, they will more than pay for the stolen water through strengthening the sponge structure around

the rose roots, by enlarging the feeding zone to a slight degree, and by regulating the temperature.

Most market gardeners would probably consider it a bid for low-quality produce were they to encourage a weed growth in their gardens. Yet, when labor became scarce during the late war, not a few gardeners found the weed an unexpected friend. Here is a report of one such case. This gardener has long been a heavy producer of vegetable crops near a large city. Labor shortage hit him at the most critical time; the draft left him with only a small percentage of his original help. He was forced to restrict his garden operations at the outset. Then after his crops were in, he lost more of his help. This left him with no alternative but to neglect a part of his land that had been planted. And there was where the unexpectables began bobbing up.

To begin with, the planted vegetables that he had discarded went right on growing along with the weeds. "And imagine what I found when I happened to go over to that section of my garden one evening!" he said to me. "There they were, a lot of fine vegetables sticking up through the weeds. I harvested some of my very best vegetables right out of that weed patch; from the very weeds I had long fought as enemies: pigweeds, sow thistles, nightshades, sunflowers, ragweeds -- even bull nettles."

This man said he was even more amazed at his production the following year from that weed-patch land. That area became his main garden the next season, and he started out to keep it clean. He admitted that his experience with weed gardening the previous year hadn't quite convinced him that he should give up his clean cultivation. But labor again -- he was forced to leave the weeds on some of his vegetable blocks. And he harvested his best vegetables from this weed-infested land. He was now certain that the weeds had not only enriched his soil while growing with the vegetables; the weeds had given his land a dose of much-needed pep.

It took an excellent farmer, a farmer in whom my mother had high confidence, to convince her beyond any doubt that weeds in a potato field could actually mean the difference between a good crop of potatoes and no production at all. Our neighbor had planted a fairly large field of potatoes, then for some reason was not able to take care of the whole patch. Weeds, mostly pigweeds, moved in and the potatoes soon disappeared from sight. Then to make matters worse, it turned out to be a dry season, the drought and scorching heat hitting the potatoes right when they needed moisture most. The potatoes in the clean field soon turned a bluish green, a sign they were done for. The weedy part of the field remained green longer, but our neighbor, supposing that the weeds would themselves put an end to the potatoes if the drought hadn't already done so, concluded that his potato crop for that season had fizzled out and let it go as just another stroke of hard luck.

When digging time arrived, he decided to plow his entire potato field, more to get it ready for fall turnips than because he expected any potatoes. It still hadn't rained to amount to anything and the soil was extremely dry and hard. From the clean part of

the field he turned out a few marbles; nothing worth picking up. But when he got into the weedy area he met with a happy surprise. He turned out several sacks of excellent potatoes. The potatoes were of only fair size but of a superb quality. After seeing that irrefutable demonstration of what could come out of a weed patch, Mother thenceforth accorded the pigweed considerable respect -- so long as it kept clear away from her choice vegetables.

One woman showed me some Bermuda onions she had harvested from a jungle of weeds. Every onion was a picture of perfection. "I thought the onions in that part of my garden were gone because I never could get the weeds cleaned out of them," she told me. She then showed me the onions she had harvested from her cultivated rows. "After all my work -- look at the difference! And my weed onions are keeping better, too. Not a one of them is rotting!"

The clean-land onions were only little more than half the size of the weed-patch onions. I was a bit surprised there, because her weeds were growing entirely too thick. However, onions collect their food materials in the shallow surface of the ground, excepting where there are weed roots to open up the lower soil. As it happened, practically all of this woman's weeds were deep divers. While they seemed too thick to feed very deep, they still fed deep enough to provide the onions with a larger than usual feeding zone.

Annual smartweed

Ground cherry

Sow thistle

Any farm boy can tell you that the best watermelons come from the weediest part of the patch, even from among the nettles that are thick with thorns. A farmer told me he harvested his best pumpkins from a plot that was covered with jimson weeds. Most cucurbits, like muskmelons, pumpkins, cucumbers, etc., dislike grass particularly, but often do well among weeds if the latter are not too thick.

And as a final word about mothering crops with deep-rooted weeds: don't expect miracles, especially if your soil has received one-sided treatment for a long stretch of years, or no constructive treatment at all. If you approach this type of farming seriously, you will discover that you have a means of improving your land -- and doing it without harming your main crop. All of the weeds mentioned so often in these discussions make excellent mother weeds -- if you control them.

However, anyone who expects to take a mediocre or poor piece of land and get a good crop of vegetables from it solely through mothering the vegetables with weeds, is likely to be in for some real disappointment. The weeds, if handled correctly, will do constructive work in the soil -- but they won't perform magic. Nature is no magician; she is a slow, reliable builder. One never loses by following her laws.

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Weeds -- Guardians of the Soil

by Joseph A. Cocannouer

7. Weeds in the Rotation

WHILE it is possible to build a sound rotation practice through a proper shifting of the regular crops, so long as legumes play a major part in the scheme, nothing can quite take the place of deep-foraging weeds as one of the links in the rotation chain. Deep-diving weeds do a complete job of revitalizing land. Being Nature's tillers in the lower regions of the soil world, when employed as a green manure the deep foragers enlarge and strengthen the feeding zone for the crop that follows. Weeds employed in this manner maintain soil balance as few other fertilizers can. Since the main reason for crop rotation is to establish and maintain a balance of food materials for the cultivated crops, where there are helpful weeds at work the farmer has double assurance this will be accomplished.

Soils, like dwelling houses, need an occasional overall cleansing, no matter how fertile the land may be. As stated elsewhere, toxins or toxic substances often get into the soil, either through running the same crop on the land for a long period of time, or as the by-products left from organic decay, or through poor tillage practices. Wherever vigorous bacteria are abundantly present, as they always are in a normal soil, some toxic substances may result from their work. These substances are not food materials, and though not harmful to some crops they can be more or less injurious to others.

Where such situations obtain, a mixed crop of deep-foraging weeds will do a good job of cleansing. Exactly how the weed roots do it is not clear. But heavy weed fallowing has been known to have a markedly beneficial effect on toxic soils. Whether the weeds transform the toxic materials, or merely distribute them so as to make them less harmful, I am not certain. But I am certain that weeds, handled properly, will both purify land and enrich it at the same time.

Where there is a mixture of weed varieties, as is usually the case where weeds serve as one link in the rotation scheme, toxic materials that might be missed by one set of roots will be taken care of by another. If a farmer wishes to be sure that a piece of

land is made safe against toxic materials for some exacting crop, he should precede that crop with a vigorous crop of annual weeds thoroughly disked up and turned under -- just after the weeds have wilted and started fermentation, but before they become dry. Wilted weeds will decay much more rapidly than will those turned under fresh.

Many garden areas, as well as flower plots, after they have been producing for several years, reveal the need of being toned up; show that they need a general house cleaning, no matter how much intensive care the plots may have previously received, or how rich they may be in plant food. "Why is it my garden won't produce like it used to? I fertilize and everything -- " is a question I often get from gardeners. What is needed in a great number of such cases is an all-round cleansing of the soil. Which is the same thing as saying that the land needs to be turned over to weeds for a season. And don't forget that the weeds must always be worked back into the soil, else soil depletion may be the harvest instead of soil purification.

Controlled weeds, employed as soil builders and soil purifiers in a crop rotation -- that is exactly what I mean! After the farmer has fitted the weed crop into his rotation scheme, he will find the weeds taking their place as his reliable helpers without any disturbance of his rotation setup. The real pain will come from having to adapt himself to new habits; from having to admit that his weed concept has in the past been wrong. If a field happens to be weak in the right kinds of weeds, he may find it desirable to encourage those weeds to take hold. He may find it necessary to plant weeds and actually coax some of them to grow where he wishes them to grow.

On most land, particularly weak land, annual weeds used in a rotation should be given two years to make a start. The first crop is likely to have a tougher job than any of the subsequent ones. Growth may be scanty owing to a scarcity of weed seed -- if there was no planting of the weeds; or the surface soil may be so weak in fiber that it bakes readily, thus choking the young weeds soon after they come through the ground; or the subsoil may be extremely hard to drive through. It will often take a second crop even when the weeds are given all possible encouragement, or maybe a third or fourth crop, before much constructive work can be in the lower soils.

And abandoned or badly eroded land may require more than four years before there will be enough deep divers to accomplish a great deal. On such land all available weed seed should be planted copiously. In most cases the weed growth, after once well established, should not be left on the land more than two years. The valuable weeds in such situations commonly drop in efficiency after the second year of heavy growth, because by then less valuable weeds start taking over. The deep divers become thinner and thinner, and grass, a more persistent fighter after the weeds have strengthened the soil, creeps in. While this habit of grass is desirable in pasturelands, it has no place in cultivated fields.

Owing to the fact that most soils are likely to be deficient in nitrogen, the element which is the basis of the valuable protein in plants, it will be better to turn the weeds

under when the majority of them are at the flowering stage. The nitrogen content of the leaves and stalks is generally greatest at this period. Since this valuable nitrogen has been gathered from the subsoil below the reach of most cultivated crops, a lush growth of weeds worked into the surface soil may add more nitrogen than a growth of legumes which supply the nitrogen through their nitrogen-fixing bacteria.

In turning under any kind of a green manure, whether weeds or legumes or what not, modern farmers or gardeners may well take a page from an ancient's guidebook of farming. Said Marcus Cato, grand old Roman friend of the land: "Coarse materials should not be applied directly to the soil; they should be processed in the manure pits first. If the latter operation is not practicable, the green materials should be cut and permitted to start decay before inculcating them into the land. One is unkind to the soil who asks it to do the work which has been assigned to the farmer. The soil's work is to feed the plants. It cannot take on the extra work without lowering crop production."

In other words, green crops should be cut or broken down and permitted to *wilt* before working them into the soil. This may seem like an unimportant operation. The wilting of the weeds, I mean. Yet it can easily mean the difference between quick decay and having the materials lie in the ground a long period before disintegration is complete. If the fermentation is permitted to start above ground, the decay processes will usually continue without check until the stuff reaches the fiber stage.

The fact that one may not have much choice in the selection of one's garden plot in town need not deter one from having a good garden and also supporting the soil as Nature would do it. Poor land can be transformed into good soil -- but not by persistently stimulating it with shots of chemicals as some gardeners do. If a gardener has depth to begin with, he can build very poor dirt to the point where it will give him excellent vegetables, if he will use weeds as one of his building agents. Seldom is there a piece of ground that weeds can't straighten out if the weeds are directed. Where possible, weeds should be put to work along with barnyard manure or compost in order to hasten the job. If the land is extremely obstreperous and the weeds do not move in readily, it is good gardening to help the weeds take hold. Gather the seed of desirable weeds and plant them. Gardeners in England are following this practice at the present time, and successfully. Recently European gardeners have found that annual weeds -- many of them our own familiars -- make it possible for vegetable growers to get production higher in both quality and quantity than what they received before discovering these weed values.

To supply "weed mothers" most advantageously to the garden -- or weeds for special green manure -- as has already been suggested, the gardener should know exactly the month or months that the most valuable weeds make their best growth. With this knowledge, when he has ample garden space it is often possible to get a fine green manure, made up entirely of weeds, on the part of his garden where he plans to plant his late vegetables. If he is in a region where there is time to permit the weed growth

to remain until strong root systems have had a chance to develop, the land will be greatly improved for whatever crop or crops are to follow the weeds. The weeds in such a case will need to be severely disked or otherwise broken up, and permitted to wilt before being inculcated into the soil. Then the land should be double disked, or given an extra spading if the garden is small, so as to destroy large air spaces. Such a weed crop will enhance the productivity of the land more than anything else, with the possible exception of an abundance of well-rotted barnyard manure or correctly built compost -- or a combination crop composed of inoculated legumes and annual weeds.

When late summer and early fall are not parched, it is often possible to get a good weed growth in the garden before frost. Gardeners should take full advantage of these weeds, unless they happen to be growing fall vegetables in a manner that prevents their doing so. This autumn crop of weeds can with advantage be turned under without any preliminary mutilation, and the land left in the rough throughout the winter. The loose condition of the land will permit a mellowing of the soil through freezing. Then, too, at the end of the gardening season there are plant remains, etc., all of which are valuable. This material will help to replace the plant foods that have been removed in the vegetables. The gardener can use these summer leftovers in various ways, but the best procedure is to turn them directly into the soil unless he is in a position to make them into compost.

In any case, he shouldn't burn the stuff. Burning, since the ash is left on the ground, is of course better than carrying the rubbish off; but burning destroys the fiber which is probably what the soil needs more than fertilizer.

In the April, 1932, issue of *The Country Gentleman* there appeared an ably written article by J. E. Cates, treating of weeds as soil-building green manures. Weeds, used as a rotation link, were being employed as a means of fertilizing the land in some of the tobacco districts of the South. Mr. Cates found that the tobacco growers had learned, through trial and error, that land which had been weed fallowed immediately preceding tobacco not only gave an increased tonnage but also turned off a higher quality product than that obtained from any other fertilizing system. Commercial fertilizers, various green manures other than weeds -- not any of them gave a harvest that came near that obtained through green manuring with weeds.

And the weeds employed were those common in most sections of our country: common and giant ragweeds, lamb's quarter, thistles, sunflowers, to mention a few that belong in those sections. All of these weeds have penetrating root systems. According to the tobacco farmers, the weeds gave them a superabundance of organic matter, and in a condition especially demanded by tobacco. Here is a clear example of how farmers, ignoring the bugaboos of the usual run of weed publications, were courageous enough to crash the long-established barriers of superstition, and to their outstanding benefit.

And with tobacco at that. Tobacco comes very close to being the most exacting of

crops so far as soil is concerned. I had ample opportunity to discover the idiosyncrasies of tobacco while in charge of an experiment station in the Philippines. Every observant tobacco grower knows that the quality of the leaf is very largely dependent upon the type of soil on which it is grown. There was no question among those southern tobacco growers as to the value of green manuring tobacco land with weeds. Cash returns spoke for themselves.

Notwithstanding the tobacco grower's marvelous results secured from a green manure consisting of mixed annual weeds, I am convinced that a weed-legume combination is best as an unfailing system of soil improvement. A crop of inoculated legumes, interspersed with annual weeds, both growing vigorously as companions, is the superb fertilizer for building up and holding the fertility of soil. This is a system of manuring that can be adjusted to all conditions where plants will grow at all, for there are both legumes and annual weeds adapted to nearly any condition. These companions need only to be put to work.

If it is necessary to plant the weeds in order to secure a desired stand, then the weeds should be planted. Furthermore, extremely poor land should be stimulated if such is necessary to induce the weeds to take hold. A farmer will find plenty of such stimulants on the market. For a good rotation on land that still has considerable life in it, the weeds as a general rule will not need to be planted in most sections, though planting weeds should be looked upon as sensible agriculture fully as much as is the planting of the legumes. Weeds should be welcomed on land that is under improvement, because the fact that the weeds are growing there means they are naturals in that locale and ready to get to work constructively. With the weed-legume combination, the weeds will pump the nitrogen and other food elements up from the lower soils, while the legumes "manufacture" the nitrogen in their nodules. Food put into the surface soil in that manner certainly will mean maximum fertilization -- achieved according to natural laws.

Whenever I think of weeds as agents to prepare the land for some special crop, I am reminded of Granddad Olsen and his potatoes. Granddad Olsen was past eighty at the time I visited him. He had staked his claim in the Run. A pretty good claim, too: some small bottoms along a rocky creek, and quite a bit of other tillable land that wasn't overly sloping. Granddad, like most of the early settlers, had done well for several years. His land had produced abundantly and he had hauled off his crops without stopping to realize that his soil could not keep on turning off such produce without some assistance from him.

But when the years began to close in on him, Granddad Olsen realized abruptly that something had happened to his farm. "When I think of them good acres I used to have, seems like I ain't got no farm anymore!" The tears welled into his tired eyes. "Eighty-three years old, and now nothing hardly left!"

It was such a common story: good land worn out or lost because of mismanagement. He told me that Jack, his youngest son, was farming the place the best he could, but

now they didn't have a piece of ground where they could grow decent potatoes. "Used to be I could win with my taters at the county seat -- I mean the county fair -- most every year. Now we can't grow taters hardly fit to eat!"

To cheer Granddad up a little, I called his attention to a small field of weeds, around an acre, that lay between his old stable and the creek. From where I stood, it appeared like a good assortment of weeds, and I could see that the big weeds had been able to hold their own against intruders. The patch was somewhat like the weed coves of our pioneer days, only larger.

"There is your potato patch waiting for you," I told him. "Those weeds down there have probably built you a potato soil as good as any you ever had on the farm. How long has that been a weed patch?"

The old man looked at me thoughtfully for a moment. "Gracious -- for a long spell! Used to grow truck down there. And you say weeds make dirt good for taters?"

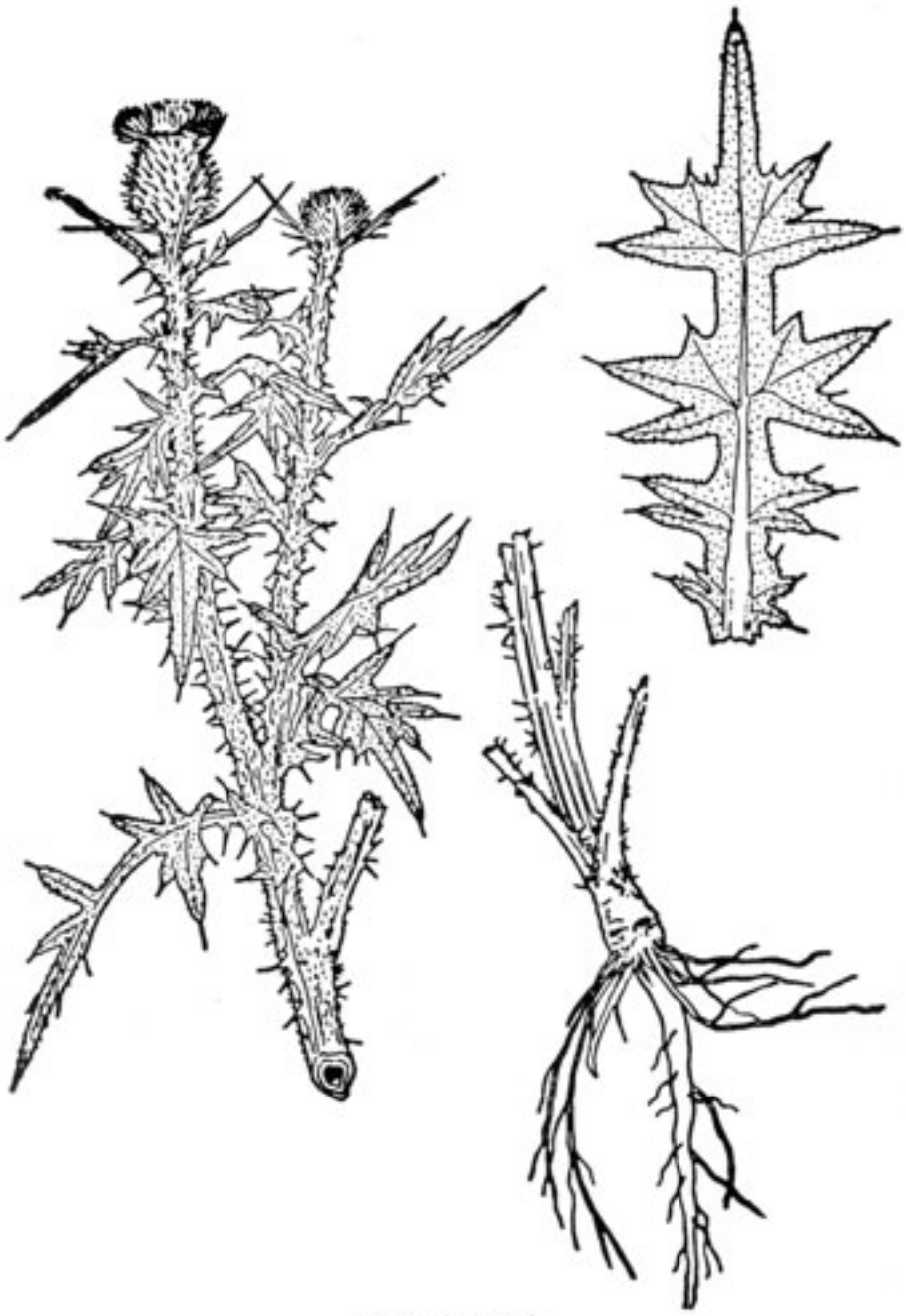
"Nothing can do it better," I assured him. "But you'll need to have Jack get in there and roll or disk the weeds before turning them under. And be sure they are turned into the soil thoroughly. Don't burn 'em! That is, get those weeds turned into dirt if you wish to raise prize-winning potatoes again."

"I declare! " Granddad's eyes were sparkling now. I knew he was thinking of those potatoes of the long-ago county-fair days. "I'll shore have Jack 'tend to them weeds 'fore tater plantin' time!"

Granddad then pointed to a denuded field that lay a short distance to our left. The field looked as if something had rolled the soil up like a blanket and then carried it completely away. "Now wish you'd tell me what to do with that field!" he sighed dolefully. "It growed good crops one time -- now look at it! Won't even grow weeds!"

"It formerly grew good crops of weeds?" I asked. There were small, sickly clumps of thistles and common ragweeds that were indicative of "lost soil."

"Lots of 'em oncet -- all kinds. You can see what washin' has been doin'."



Bull Thistle

Again I called Granddad's attention to that field of weeds below his old barn. "You have an abundance of weed seed down there," I said. "Why not re-establish the weeds up there on that slope? Not all of those weeds growing there below your barn will be willing to take hold on your eroded slope without a lot of coaxing; some of them you probably can't even coax to grow up there. But some of the most valuable weeds will make a go of it if you help them a bit. Try the pigweeds and horseweeds and those bull thistles that are growing so well down there -- "

"But you don't mean to plant weeds!" Granddad interrupted me. "Why, everbody would think we was crazy if we started doin' that! I can't imagine Jack a doin' that at all -- "

"Then you'd rather have that field lie there and continue to get worse instead of better?"

"No -- I didn't mean it that way! I'd be willin' to do most anything, to get some dirt back on that field! But to plant weeds! I'll talk to Jack about it; see what he thinks -- "

I learned later that Granddad Olsen followed my instructions about his potato patch, and harvested some excellent potatoes. But I don't know whether he ever planted weeds on his eroded slope or not. Probably didn't. Eighty years of superstition wouldn't give way easily. He couldn't risk being caught planting weeds, though the weeds could have helped him save his farm.

But I predict that in twenty-five years, possibly sooner, farmers will have accepted many of our common annual weeds as a vital link in any constructive rotation scheme.

Someday they will gather and preserve the seed of a large number of weeds that are now considered pests, just as they save the seed of sweet clover and a few other wild legumes. Food producers will awaken to the realization that a right kind of weed science is going to be necessary as a practical part of our agriculture if our farmlands are to be saved and permanently improved.

Green manuring land with weeds, if the greatest value is to be obtained from them, may call for weed treatment other than that of turning the weeds loose to grow as they will. Thick growths may have to be thinned in order to encourage the growth of strong root systems. However, with a dense growth of healthy weeds, a fairly large percentage of the plants will fight their way down into the lower soils. Nature will employ her soil builders constructively -- if man gives her a chance to put her laws into operation without any interference from himself.

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Weeds -- Guardians of the Soil

by Joseph A. Cocannouer

8. Weeds and Pasture Improvement

WERE it not for the constructive work of several important pasture weeds, most wild-grass pasture areas in the United States would today be barren.

In the *Chicago Naturalist* (Volume 8, Number 2, 1945) there appeared an article entitled "The Role of Weeds in Maintaining the Plains Grasslands," by Anna Pederson Kummer, which substantiates my own findings. Weed growth -- or some special domestic crop capable of doing the work of the weeds -- is necessary for the return of the grass to land where the grass has been completely killed out, or seriously thinned through overgrazing, sheet erosion, or because of a long period of drought.

While the author of this penetrating article treats only of the short-grass regions of our middlewest and west -- that fabulous land where the buffalo and antelope by the millions roamed and grazed -- the natural laws by which those heavily grazed areas were sustained are invariable. The unbelievably large herds that gathered their food almost entirely on the short-grass plains throughout countless decades must at times have come close to the borderline of famine. Yet the herds survived because of the work performed by weeds.

I am convinced that the same laws of Nature apply to tallgrass regions no less than they did to the buffalo ranges. Some of the observations of the author of the article in question are particularly worthy of note here. There were, she assumes, dry periods during those buffalo years, just as there have been modern dust-bowl periods in that same section of the country. During those extremely dry years weeds took over the plains and provided food for the roaming wildlife of many kinds. Not food equal to the short grass, probably, but enough to support life.

And those same weeds are out there today in those once short-grass plains, doing their level best to save the soil against the modern destructive tillage practices of man. Dust storms can, in a very large measure, be prevented by the correct utilization of those plains weeds!

But, though vitally important as an emergency forage, important in staving off what would otherwise have meant certain death to millions of bison, that was not the weed's greatest value, even to the bison themselves. The weed's real worth came through its ability to pave the way for the return of the grass.

The plains weeds -- milkweeds, thistles, tumbleweeds, ragweeds, to mention a few -- are almost all on our list of constructive weeds. Quoting the aforementioned author directly: "While the weed cover seems a deterrent to successful reoccupation of the short grass, it is actually necessary to that process." And again, "Without them [weeds] the short grass could not have survived as a climax vegetation."

Wild Mustard

The weed-grass relationship in rebuilding grasslands, I feel reasonably sure, holds almost invariably true not alone in our short-grass regions but for all types of dryland grasses that normally form prairies or meadows. I have seen this law functioning in the desert regions of Africa where a few persistent weeds serve as the forerunners of

the grass that is ever struggling to get a foothold on the borderline of vegetation. In the tropics, where rainfall part of the year is enormous, some of the more intelligent native farmers are careful not to overgraze their small *kogonales*, or grazing grounds, lest the grass become so weakened that jungle weeds are able to move in and take over.

The grass will fight its way back if the carabao and cattle and horses are kept off, but usually only after the weeds have transformed the soil. In America this law is in evidence everywhere, both in hay meadows and pastures. Pasture grass, once it has given out, will not often re-establish itself until the soil has been refiberized by weeds or some domestic crop that has the power to do the job.

What actually happens in the interesting relationship which exists between grass and weeds is this: prairie grass demands a soil that is highly fiberized; a soil that is porous. In a good pasture or lush meadow there is an abundance of sod, and the grass maintains this sod condition as long as normal growth is not interfered with; or as long as the soil, for any reason, does not compact around the grass roots. But when any adverse factor does come along and kill out the grass, usually grass cannot move back in and refiberize the soil by means of its own roots. It must wait until some other agent does the pioneering job for it. Then the grass moves in, takes over the work, and continues it.

This pioneering agent of Nature is the so-called weed. The weed roots unlock the tight soil, fill it with fiber, and thus re-establish its porosity. *But the weeds do not drive out* the grass. Something else does that. And fortunate is the farmer who is able to watch a strong crop of weeds take over his pasture immediately his grass has become seriously weakened. The weeds also lessen erosion, if the land is at all sloping, in addition to getting the land ready for the comeback of the grass.

Mr. Basil was a businessman and an absentee landowner who for some time had been urging me to go with him and inspect a new place he had just purchased; wanted me to tell him especially what to do about his pasture. The pasture was a deplorable sight, he said; not enough grass on thirty acres to support a cow. I was not overly enthusiastic, for I had long since learned that absentee landowners were all very much alike. They want you to give them advice on how they should handle their land constructively; then proceed to do nothing about it, though they'll admit your ideas are good. But when Basil said that this new pasture of his had the best crop of weeds on it he had seen in all his born days, I was all eagerness to go.

That pasture was a superb soil-building demonstration. Nature was gloriously at work. As we walked over the area, I gave Mr. Basil a pasture improvement lecture which stuck -- I hope. Actually, it was Nature herself who did the lecturing. Weeds -- weeds everywhere, fairly shouting one of Nature's laws in operation. There were annual ragweeds, horseweeds, thistles of several kinds, prairie pigweeds, wormwood, ironweeds -- almost all of our familiar land improvers plus a number of worthy extras.

And every one of those weeds was at work fiberizing the erstwhile beaten and overgrazed pasture; busy getting the land ready for the regrowth of the grass. Mr. Basil had a superb pasture in the making and didn't know it.

Most of us are familiar with our old reliables in pastures; the weeds that are classed by most folks as undesirables: thistles of several kinds; the tumbling tumbleweed, but before it went tumbling. Then there is the milkweed, more than one kind, to be exact; several wild legumes; goldenrod, the queen of autumn flowers; common and giant ragweeds -- the list could be a long one for any community. Most of these pasture weeds are deep divers. Nature has assigned them a vital part in helping to maintain the earth's green carpet.

Amd the grass will return on pasture areas wherever those weeds are vigorously on the job, not only on Mr. Basil's farm, but in any pasture where the weeds have taken over. That is Nature's law for the rebuilding of grasslands. The time of the return of the grass will depend on how long it takes the weeds to complete their preliminary fiberizing. The land may have become so depleted that this will take several years, even decades, or the grass may move back in two or three seasons. In successful pasture building, man works as assistant to Nature in carrying out her important law.

Grass has the power to rout the weeds when conditions are right for the return of the grass. This is also an interesting segment of the weed-grass cycle. Grass can conquer the weeds when the soil is rich in fiber. It is not uncommon to hear farmers complain about weeds killing out their grass. "Looks like my pasture is goin' to be all weeds pretty soon! Weeds are killin' out my grass more every year." Just the reverse is really the case. The grass gives way because the soil particles have run together, thus destroying the porosity so essential to grass roots. When this happens the weeds take over -- and do the very things that Nature has assigned them to do. Sometime later the weeds will be replaced by the grass. Wild meadows all contain weeds, and many of those weeds are constantly shifting about in the meadow or pasture; imperceptibly improving weak spots so the grass can move back.

It is hard for farmers to conceive how the weeds can possibly be helping their meadows when the superficial evidence is so strongly against the weeds. There are plenty of indications that many of the weeds companion with the grass, perhaps to the benefit of both, in somewhat the way Sol Benson's corn and pusley roots worked together, the weed roots leading the grass roots a bit deeper into the soil. But the chief value of weeds in grasslands comes from their fiberizing powers; from their ability to strengthen the weak spots in the upper layer of soil, and to fill those spots, as well as the lower soils, with fiber.

I always like to defend the common annual ragweed. These weeds are a familiar sight in most pastures. Cows eat the rags because, for the cattle, ragweeds are ration balancers; bovine vitamins, they could be called. They provide something that more dignified forage does not supply. And those large ragweed patches in the pasture have

not driven out the grass! Ragweeds are quick to take over once the grass weakens, and it usually takes vigorous grass to rout the weeds. But when the ragweeds do move out, either through man's help or when the grass is able to overpower them, the weeds leave the soil in far better condition than it was when they took over.

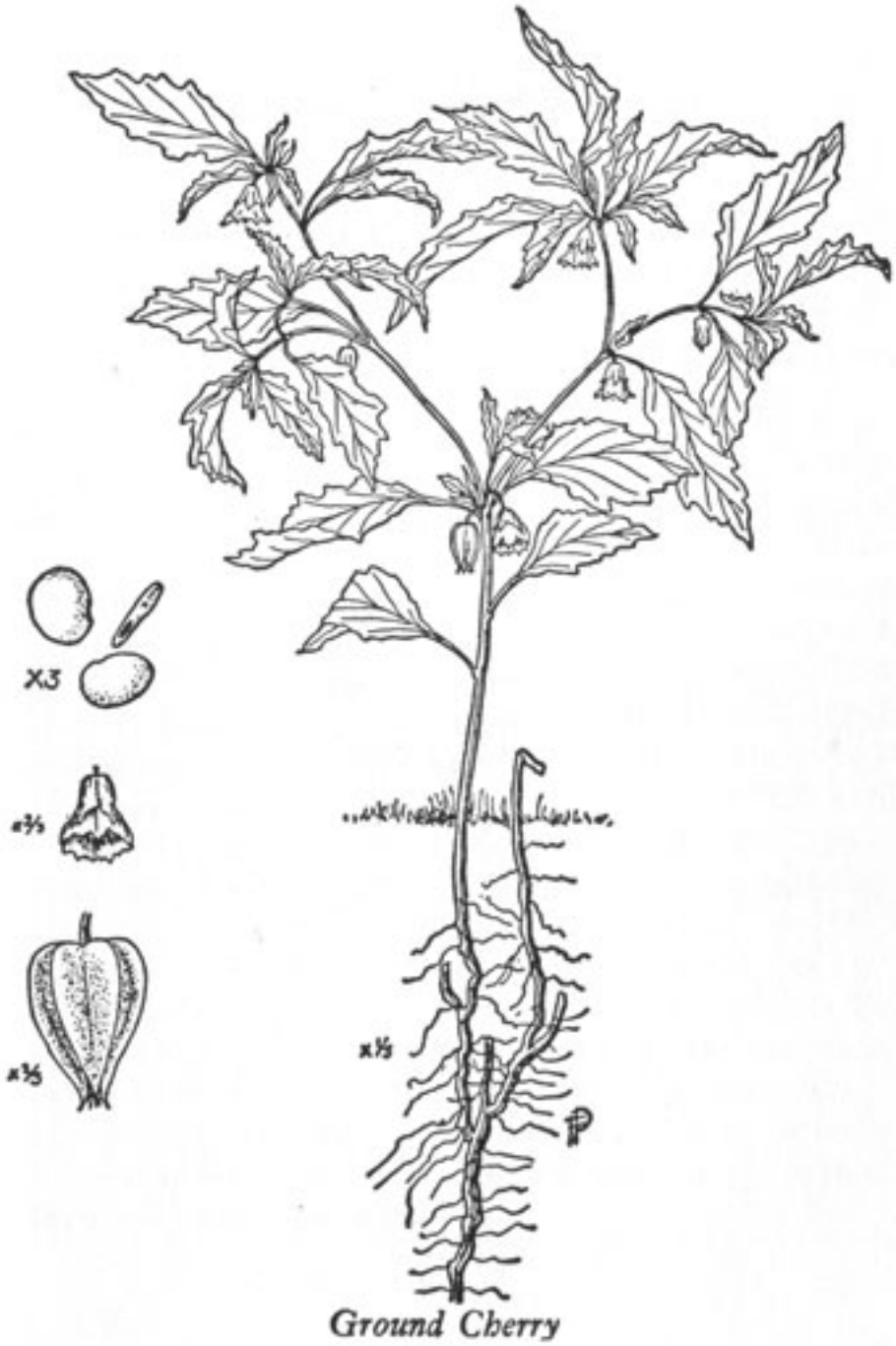
During the drought of 1936 many pastures and meadows in the Mississippi Valley were injured or completely destroyed -- apparently -- by the relentless heat and dust-laden winds. For a time it looked as if deserts had moved in a few years ahead of schedule; that schedule which prophets have assigned them. But right when many pastures looked most desolate, a change took place abruptly in the desertlike landscape. Weeds shot up in many places, almost overnight. I remember that the most conspicuous to appear in my own community were annual ragweeds and blackeyed Susans. The author of the article on weeds in the plains' grasslands makes a statement which did not need the short-grass region for verification: "Probably there is never a dearth of either variety or number of weed seed in the soil." The Susans came on and thrived until in bloom they resembled a solid yellow carpet -- acres and acres of them where they had not been noticed before.

But after two seasons of weeds the grass moved back onto the land, in pasture after pasture thicker than it had been before the drought. The big drought in the long run had proved beneficial to many an acre of grassland. The severe dry siege gave the hardy weeds a chance to open up and fiberize the soil. Farmers in many sections found themselves with better pastures three or four years following the drought than they had seen on the land for several years previous to it.

I have been asked many times where the grass came from. The fact of the matter was, a goodly portion of the grass crowns had not succumbed completely. Now, with the soil improved by the weeds, when the rains returned green shoots quickly appeared, coming out of the dead-looking clumps. There were grass seeds everywhere, too, just waiting for those favorable conditions in order to sprout. This new grass added immeasurably to the rebuilding.

Weeds, and probably grass also, seem to produce two kinds of seed at the same time: seeds which sprout readily when growing conditions are favorable and which play the main role in maintaining the life cycle of the plant; and seeds which seem to germinate best under abnormal conditions -- when that particular species of plant is facing a severe struggle of some sort. Some weeds produce seeds that lie dormant for a long period of time, though sprouting conditions may appear to be excellent. Cockleburs, for example, are known to produce several types of seed on each plant. Some of the burs germinate in one year, others in two years, and so on until there are some seeds that remain dormant for five years or more. Since weeds are essential in maintaining natural soil fertility, Nature makes certain that no situation can arise where varieties of weeds are not there and ready to go to work when necessity calls. Only when the land has been completely peeled by erosion, and the surface soil together with all weed seed has been carried away, will there be a complete dearth of weeds on the land.

In some sections of our country there are encouraging signs that farmers are beginning to realize that something constructive must be done toward repairing the native pastures which have in many parts just about vanished so far as forage production is concerned. Some good work in pasture improvement has already been done, and this movement will accomplish lasting good if it steers the right course. It will not be difficult to get a temporary response from the grass by means of superficial scratching of the land and the application of stimulants., But there is danger that such treatment will not build a permanent pasture.



Ground Cherry

As already pointed out, the death or weakness of the grass, even where overgrazed, is likely to be due to the soil's having compacted. The grass cannot come back

permanently until the soil has been refiberized; made porous. This, Nature, if left to go it alone, will do with her weeds. Man can help with domestic legumes, particularly those that have strong root systems. Clover along with several other legumes will do the fiberizing work, whether planted along with the grass or before it. The grass roots will follow the clover roots down into the soil to a fair depth, and from then on will do their own fiberizing; will build their own permanent sod.

The legume-grass combination will work the same as the weed-grass combination in pasture improvement. If weeds have already taken over and done a fair job of fiberizing, the clover should still be planted for the quick nitrogen it can supply. Young grass needs an abundance of nitrogen, and the weeds and clover will take care of that. Terracing and the application of lime may be necessary in many sections, and an application of rock phosphate will commonly be found advantageous. But better keep away from most of the stimulants, if not all of them. Build your pasture Nature's way if you want it to last.

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9. Weeds in the Compost

COMPOST farming is a type of soil fertilization that dates back to the first recorded agricultural history. One modern dictionary defines compost as "a fertilizing mixture." Which really doesn't define a great deal, for there are many fertilizing mixtures that fall far short of properly built compost. In ordinary language, compost is what results when vegetable materials are thrown into a hole or stacked up on the level in some out-of-the-way place and permitted to rot as they will.

Scientific compost making, however, follows a more exacting formula. A true compost is a mixture of plant ingredients, all right, but there is more to the processing than is generally believed. Actually, almost anything organic short of saw logs can be turned into good fertilizer if the right procedure is followed.

Probably the first compost formula was the one introduced and developed by Marcus Cato, a Roman scientist, statesman, and general all-round farmer who lived and lectured on agriculture some two hundred years before the Christian era. At least, I think Cato's compost formula is the first that history records. Until the fall of Rome, the teachings of Cato were the last word in farm management. There is little doubt that this old Roman was one of the world's greatest agriculturists. Many of our modern agricultural discoveries were advocated by him.

Cato was a strong believer in compost as *the* soil builder. Indeed, one gets the idea from his writings that he considered compost making and compost fertilization indispensable if one expected to hold one's land to a high production level. Farm animals were kept as much for what they could supply to the compost pits in the way of manure as for any other purpose.

Cato's method of compost making required two deep, covered pits, one to hold the finished fertilizer, the other to take the stuff as it came from the barnlot or field. On the larger estates the pits were in charge of men who were thoroughly versed in the science of compost making. As a first step in getting the materials ready for the pit,

Cato directed that everything should first be scattered in the corrals or used as bedding in the animal stalls, to be trampled under the feet of the livestock. Treating the vegetable materials in this way did two very important things: the trampling broke up the roughage and insured quicker disintegration in the pits; also the spongy material collected the liquid manure which otherwise would go to waste. After this initial treatment, the ingredients went into the pit, where they remained a year. During this period the stuff was turned periodically to bring about uniform disintegration and assure against loss from firefanging.

One of Cato's most interesting -- and certainly progressive -- agricultural principles was that the raw materials must always be composted before being inculcated into the soil. This, he claimed, saved the plant roots from having to do a lot of extra work that was not directly connected with the production of crops. He wanted plant food materials served ready for immediate consumption. No raw manures or other undecayed ingredients should ever be applied directly to the soil.

Curled Dock

Some suggest that the Romans may have learned compost making from the Chinese. I doubt this, for the Romans seem to have employed only dry materials for making their compost, whereas the Chinese always have preferred green vegetation. It is true that dry rubbish is never wasted in China; but during my explorings over there I never met a farmer who did not rank the green vegetation above straw and other dry refuse.

The only reason I could discover why the Chinese were partial to the green material was because the processing was quicker. A few farmers I talked to also considered the "green compost" more quickly available when applied to the soil. I found only occasionally a Chinese farmer who was building or had built what he considered a complete compost, though any of them could tell you all about Chinese composts. Green weeds would be the best possible materials for making composts, they say, but these are no longer to be found in sufficient abundance on the hills. As a general rule, like the old Chinese woman already described, they chop up the small amount of green stuff they are able to gather and apply it directly to the soil.

The people in several countries of Europe prior to the outbreak of the last war were far more compost conscious than American farmers and gardeners have ever been. Farmers in America seem to think of compost making as kid work; not a man-size job of farming. Compost for a small house garden is all right, some will tell you; but for a cornfield -- well, men have enough to do without wasting time hauling and tossing rubbish into a hole in order to get a hatful of fertilizer after waiting several months.

To compost organic materials into the superb fertilizer that is possible is a man's job from start to finish. Yet the composting of plants or plant refuse is simple in comparison with the results obtained. Nature's constructive laws are usually like that. They are exacting but easy to follow, and the returns are great.

An English agricultural scientist, the late Sir Albert Howard, was beyond doubt the outstanding compost authority of modern times. Making use of the best compost knowledge to be found in the Orient and elsewhere, he added to this the results of his own extensive experience and experiments in several parts of the world, until he came up with a formula which, if followed, results in a fertilizer that ranks with Nature's best.

Fertilizer made according to the Howard formula will re-establish balance in weak soils in a much shorter time than will any of the fertilizers with which most of us are familiar; and it reveals its richness in the harvested produce in a way that is almost unbelievable. Both quality and quantity are enhanced. In some respects, soil built up

by means of the Howard compost surpasses virgin land in that it can be held to a more uniform balance because the farmer has the soil-improving operations completely under his control.

For full information about the Howard compost, its method of processing and so on, the reader is referred to *The Soil & Health*, by Sir Albert Howard, the great scientist's own record of his life work. (Published by The Devin-Adair Company, New York.)

What I wish particularly to bring out here is the place of weeds as compost material; weeds in the light of the Howard compost. Just as the Chinese have proved through long experience that weeds, when used green, differ in their fertilizing ability, so should we expect to find that different kinds of weeds in our own country will differ in their ability to enrich the soil, both while they are growing and foraging for food materials and when they are employed for making compost. Unfortunately, our knowledge of this difference between our valuable weeds is at present very limited. What we do know is that several familiar weeds are excellent soil improvers and that all weeds rank high as compost material. Consequently, the farmer or gardener should employ in his compost as many kinds of weeds as he can get hold of, from sunflowers to carpet weeds, with all the in-betweens, and at every stage of growth.

Most farms have an abundance of compost material. Here is one worthy use for the weeds along the road or highway. Those weed areas should not be denuded. Ample weeds should always be left to hold the soil and to provide seed for the next crop. And rare is the farm that does not have some vigorous weed patches temptingly available other than the weeds along the highway: next to fence lines and in fence corners; around out-buildings and here and there in the barnlot. Also, there are those weed strips along the forest edge, or weed coves that have grown undisturbed for a long period of time. On depleted land and on eroded farms, weeds are likely to be scarce. At least, the most desirable weeds. In such cases the roadside weeds may prove to be a valuable asset capable of lending aid well worth considering in soil conservauon.

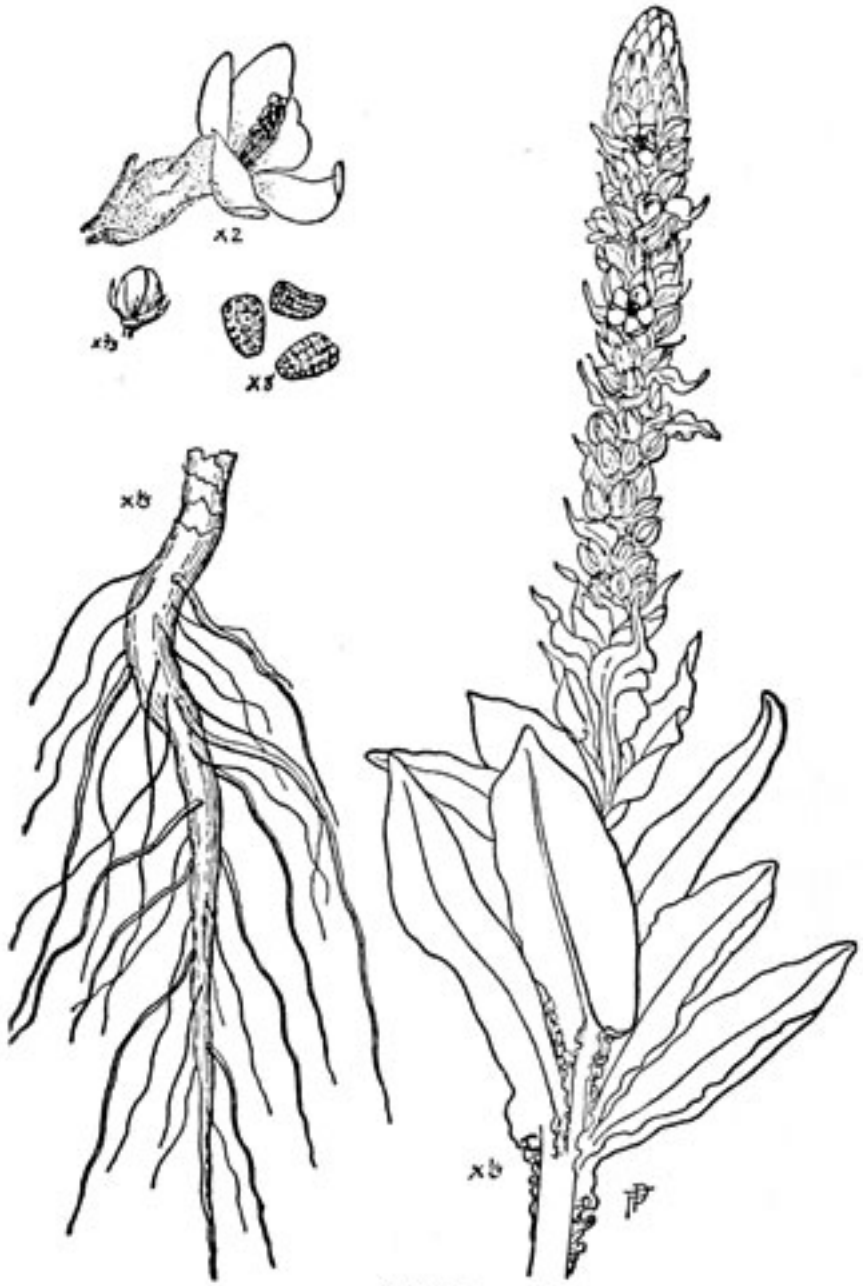
Burdock

In the small town garden, compost can really prove its worth. For all types of small gardens compost is beyond question the most economical as well as the most desirable fertilizer. This is because the Howard-type compost makes it possible for the gardener to get an amazingly high production of quality vegetables from a small plot. For vegetable plots, shrubbery, or flowerbeds, compost made from weeds combined with barnyard manure, the mixture correctly processed, will satisfy every plant-food demand. The town gardener, though his plot may not be larger than a four-by-ten table, should learn how to build compost the Howard way, and then use it for all it is worth along with green weeds turned under occasionally, and with mother weeds in his plots wherever the latter is practicable.

As a compost gardener, the town gardener will then never burn the leaves from his street trees. Fallen leaves are tops as compost material. Aside from containing

excellent fiber, which all soils need, tree leaves are rich in minerals. Do not forget that tree roots delve deeply into the soil for food and moisture. They bring up enormous quantities of these food substances, a goodly portion of which go back to the soil when the leaves fall, after having completed their work as the food-processing laboratories of the plant.

In case a gardener does not feel he can spare the time and effort to build a Howard compost pile, he can still make use of his fallen leaves in a manner that will give him a lot of feeding material for his garden, his flowers in the yard, his lawn, or his shrubbery. A simple compost stack -- or pit -- can be built to meet restricted conditions in town. And here is a word of caution about the composting of leaves: weeds should always be mixed with the leaves when building the compost, whether a shallow pit is used or the stack is built on level ground, since the leaves, when piled up alone, have a tendency to compact together. This compacting of the leaves prevents suitable aeration while the stack is processing. By alternating a layer of weeds with a thin layer of leaves, this can be eliminated. And in order to have a more nearly balanced fertilizer, there should also be a layer, some two or three inches thick, of reasonably fertile soil, this also alternated regularly with the leaf-weed layers. The soil, wherever possible, should be mixed with poultry or other animal manure, as well as a bit of slaked lime or ground limestone. If dry materials are employed for making the compost, all of the stuff should be thoroughly soaked with water as the different layers are put in.



Mullein

Being unable to meet all the requirements for an ideal compost mixture should not deter one from doing the best one can. Weeds and leaves alone will give back a very desirable fertilizer. If you have some reasonably good dirt handy, just build a three-layer stack as follows: weeds, leaves, soil; weeds, leaves, soil, etc. Or, weeds and soil; weeds and soil. Where manure is used, weeds, manure, leaves; weeds, manure, leaves, work out well. The point is, make use of those lawn mowings, fallen leaves -- all stuff that will decay in a reasonable time -- for making a better fertilizer than you can possibly buy.

No farmer or gardener has a valid excuse for not getting some value out of his weeds. If he is unwilling to welcome weeds as a green manure in his rotation, or as mother weeds in his cultivated crop, he can still compost his weeds into a fertilizer that will live up to every claim made for it. And once tried, those thistles and pigweeds and

sunflowers -- all kinds of weeds will be seen as possessing some worth, though many may rightly be pests in some situations. Some of the very worst weed villains make the very best of compost.

In a town where there are gardening enthusiasts, there should be compost clubs in which the Howard system of compost making should be studied as a science and through actual demonstrations. This can be done, and is practical. After a gardener learns through his own efforts what quality of flowers or vegetables he can harvest from a few square yards of land, that gardener will be a compost booster wherever he goes. He may even reach the point where, like many gardeners in Europe at the present time, he will plant weeds in a special plot so as to make sure of an ample supply of this best of compost material. He will discover also that practically all vegetable refuse and discards from the kitchen, lawn mowings, prunings, garden leftovers, fallen leaves -- all can be turned into rich plant food -- a far better fertilizer than he can purchase on the market.

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10. Weeds as Food

A VERY largre percentage of our soil-building weeds are in one form or another edible. Most of them are very nourishing. And my Nature-loving mother did know her potherbs. She searched the forest and meadows for her weed greens, often the very same weeds she fought so relentlessly in her garden. Mother considered the wild, eating weeds far superior to any greens that even she could grow. She planted mustard to give a bit of tang to the more delicate wild plants, or to assure our daily minerals if something prevented her gathering the wild greens. Turnip greens she grew in the fall when edible weeds were not plentiful. But the domestic greens were only for emergencies. Wild plants when available were the favorites.

In the spring, from the time of the first chirp of the little bird she always called the pewee, we were constantly cautioned to be on the lookout for the old standbys in the coves or in the protected forest spots. As soon as we reported that the young weeds were two inches tall, every morning soon after breakfast mother was off for the fields, her "yarb" kettle on her arm. Neither rain nor mud stopped her. Those weeds that she hated in her garden were now a special gift to her from Nature; weeds were now food, not pests.

Mother's weed collection was not large. I think she placed curled dock first and lamb's quarter second. Poke she ranked high. The poke weed, known for its poisonous roots, was particularly prized because it was the one weed that mother liked to cook with her meat. And because of the danger of harvesting a bit of the poison-filled root, she wouldn't trust anybody but herself to gather those "asparagus" shoots of the poke. I don't recall how mother cooked the poke shoots. I just know they were delicious.

She served up to us the sow thistle, the smooth-leaf pigweed -- but never the coarse-leaf villain. Stinging nettles occasionally came onto the table when the plants were young and tender. Dandelion and wild lettuce were sometimes combined, but as a rule they were served alone like other weeds. These two weeds were looked upon as a sort of "Sunday greens," because they were rarely abundant on or near our farm, and

Mother was especially fond of their flavor.

As I recall, our weeds were always cooked much the same way: boiled in a large kettle and seasoned sometimes with a bit of bacon or ham grease, or more often served without any seasoning at all. Each of us seasoned to suit his taste,. And it was a long time after my mother's day that I learned why those wild plants were so much more savory than the majority of cultivated vegetables: even young weeds, by the time they are big enough to start going into the "greens kettle," are foraging extensively; their husky roots are already near, or in, the lower soils, feeding in that rich store-house down there.

Pokeweed

The Pawnee Indians almost invariably cooked their weeds with meat of all kinds,

preferably after the meat had become stale. Before edible weeds appeared abundantly in their cultivated fields, the squaws were weed gathering daily in the forest and gulches. The Indian women harvested all the weeds that were my mother's favorites, plus many others. They prized the rough pigweed, and purslane they also valued highly, often drying the stems and succulent leaves of the latter for winter food. The Pawnees -- the very old members of the tribe -- ate weed roots of several kinds. The wild morning-glory and the wild turnip I remember particularly. Weed seeds were eaten, but probably not so extensively as with Indians of some other tribes. The seeds of both pigweed and lamb's quarter were harvested by some of the squaws and ground or pounded into a sort of flour to be mixed with meal in making bread or porridge.

Professor Edward F. Costetter of the University of New Mexico, in his studies of the food habits among some of the Indian tribes of the Southwest, has brought to light interesting information on the use of many common weeds as human food. The Indians of Arizona and New Mexico still employ weeds much as did the Pawnees formerly. Some weeds, however, are put to more extensive use. Pigweeds, for instance, after being first boiled, are then fried in lard. These weeds are also canned for winter food. The Southwest tribes commonly grind the seed of both pigweeds and lamb's quarter for bread and porridge.

Several years ago, while exploring in Arizona and old Mexico, I now and then ran onto small plots of wild lamb's quarter that was being grown for the seed. Professor Costetter reports that the common milkweed is especially prized in some places, the young stems and leaves being cooked with meat. The roots and young pods of this plant are eaten both raw and cooked.

The late war in Europe, despite the suffering and destruction it brought about, gave birth to a new weed knowledge that should play an important role in rebuilding some of those ravaged countries. Necessity forced the investigation of the food value of many weeds that until then had been given little attention. Some weeds that had long been looked upon as worthless were found to be highly nutritious fodder for livestock. Once these weeds were correctly processed, that is, cut and cured into hay or made into ensilage, livestock not only devoured the hay and silage, but gave back gratifying returns.

American farmers will probably be more than a little surprised to learn, for instance, that the detested bindweed, when cured into hay, gave returns from dairy cows considerably above either alfalfa or clover. Many weed experiments were carried on at one of England's leading experiment stations, where the weeds, of course, were under control.

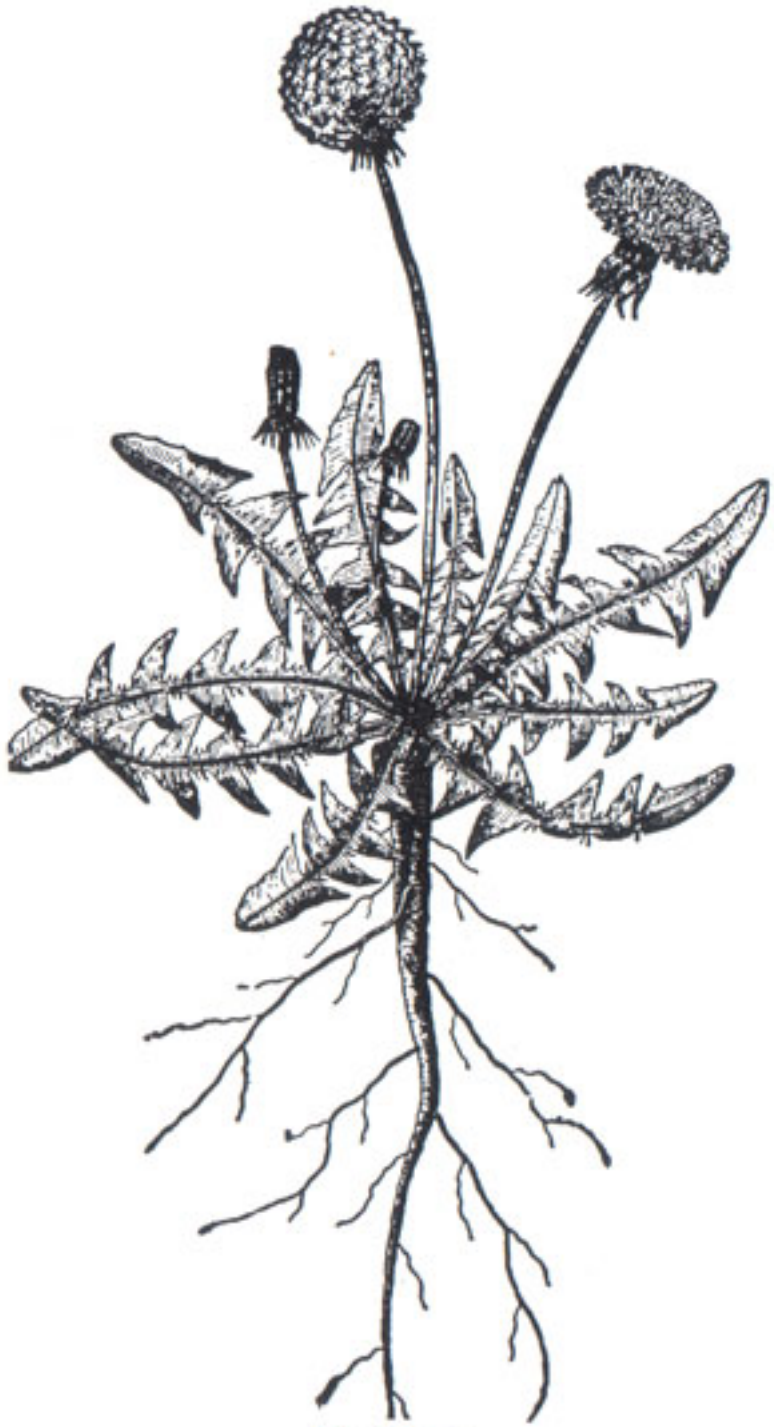
Thistles of several kinds, when treated correctly, were also found to rank high as stockfeed. Thistle ensilage is not entirely unknown in the United States. Stinging nettles, a European weed that is now established in many parts of our own country, the English investigators found to be excellent feeding, when cured, for both dairy cattle and poultry. These nettles are rich in protein, and laying hens, fed the cured

leaves and stems as a major part of their ration, showed a marked increase in egg production. With dairy cows, nettle hay produced a very noticeable increase in milk and butterfat.

How well I recall those dense patches of stinging nettles that we had to wade through bare-legged to reach the best fishing places! We could have made an abundance of chicken feed and cow feed from those nettles had we only known. Mother knew the nettles made good greens, but never dreamed of drying them and feeding them to her hens. Acres of those weeds, growing along the creek and in uncultivated bottoms, went to waste every year -- and are probably still going to waste.

The searching English scientists also discovered that many other weeds needed only a bit of special treatment to bring out their value as food for livestock. The rough-leaf pigweed was found to make excellent hay. Pigweed hay and thistle hay brought returns only slightly below those received from bindweed hay.

Any weed that gave the least promise as human food was tested thoroughly with the aim of helping out the limited ration of a hungry people. Rural America today is more or less familiar with the common yellow dock, one of the most famous greens of the South. Many southern housewives will tell you that no potherb can excel the dock in richness. And they are right. The yellow dock stands near the top of all potherbs in food value. Every garden should have a patch of this dock, especially since it requires no care once it has become established in a fairly damp spot. During spring and carly summer a few square feet of these weeds will give an abundance of solid nourishment.



Dandelion

As a general thing, American farmers have given little thought to the curing of weeds for hay. It has long been known that sunflowers make excellent ensilage. And I have seen several other weeds used in the same manner. Giant ragweeds for one. One farmer told me he obtained his best ensilage when he mixed weeds with his cultivated legumes in the silage trenches. The stock seemed to prefer this ensilage to all others. Wild hay always contains a percentage of weeds. As a rule these weeds have passed beyond their valuable food stage before the grass is ready for cutting, but stock will go for many of them after the weeds have passed through the sweat in a stack.

But not all Americans are unaware of the value of weed hay as a forage for livestock.

Lately I have had some very interesting reports on ragweed hay, and from widely different sections of the country. In every case the farmer was enthusiastic about the results he had obtained from this much-maligned weed: "Cattle preferred it to alfalfa and did well on it," one said. Another wrote me, "This hay is not bitter when cured and stacked right, like green ragweeds are. My cattle seem to like ragweed hay better than any other forage."

These farmers indicated that they were using identical methods for making the hay: the weeds are cut when lush and green, but before they become too woody. The hay is left in the swath or shock for a short period, the same as alfalfa, but when stacked it is given a bit of salt now and then as the stack goes up. These farmers seem to think that the salt in some way improves the value of the hay other than to perk up its flavor.

It goes without saying that the seed problem will enter in until somebody comes along with a satisfactory solution to it. The annual ragweeds must of course be planted each year save where a crop is permitted to go to seed on the land. Since no farmer has written me about planting ragweeds, I take it that all depended on natural seeding, or they were making hay from the common perennial which is found in many sections. However, annual ragweeds are heavy seed producers, and gathering and threshing the seed should not be difficult. A few years hence ragweed hay may well be filling an important forage niche on many American farms.

If a weed makes better hay than alfalfa or clover, then that weed *must* be good. Now, we have proof that many weeds will come close to doing that if they are cut at the right time and cured correctly. But any farmer who does not wish to make weed hay can turn his weeds into high-class ensilage. For making silage, weeds can be cut almost any time so long as they are not completely dry.

Why so many wild plants are repulsive to white people is difficult to understand, especially since many of these same plants have been ranked as nourishing food by our Indians as well as other primitive people since the beginning of time. One such plant is the common milkweed, a native perennial found generally throughout the United States. When the tender stems are boiled in two or three waters so as to remove the milky sap, the resulting product is a fair substitute for the best spinach. The small pods when cooked resemble okra -- some who have tried it consider the milkweed pod more savory than okra, though the milkweed is not so easily cooked. And the milkweed roots are not bad "potatoes" -- once you remove the original bitter taste.

Then there is the wonderful ground cherry. The ground cherry, a valuable weed in any field, has been ignored too long. Its fruit, produced in a husk, is most delicious whether eaten raw or made into preserves or pies. This weed should be a companion in every garden where it can be made to grow. One member of the goldenrod tribe has long been known among the Indians as a favorite tea plant. This variety, often listed as the "sweet goldenrod," can be distinguished from the other strains by crushing and

smelling the leaves, which have a delightful aroma, resembling anise. It is a tall, slender plant and grows along the edges of fields or near the forest where the soil is a bit sandy. The beverage made from the cured leaves is very pleasing.

Now *my* favorite beverage: sumacade. Gather the common sumac panicles in late summer when the berries are brilliant red and sour. Then squeeze out the juice in any manner you like, strain, add water, a bit of lemon, sugar to taste -- and drink ice-cold.

A research botanist remarked to me not long ago: "Rare is the weed that is not edible. I have eaten almost everything in the weed line in every community where I have lived, and have seldom found one that was not pleasing to the taste; most were delicious." As Indian John used to say: "All wild plants good. Indian eat 'em and live long time!" It used to seem to me, when I was a lad in the Indian country, that Indians did outlive white folks. I don't know how much weeds had to do with it. Old John may have been speaking with more wisdom than I at the time suspected.

I remember how as a boy I enjoyed digging and eating raw the roots of the evening primrose, but I did not know that those roots were cooked and served as a root vegetable until I had traveled in Europe. Though the primrose is native to America, it was the Europeans who first discovered that the roots were highly nutritious. This weed is commonly grown as a choice vegetable in both England and Holland. It should also be given a place in American gardens along with other favorite root vegetables.

And finally, I would put in a word for the lowly sheep sorrel, a weed found throughout most of our country in cultivated as well as neglected fields, or along the edges of woods. This sorrel has pink flowers and thick juicy leaves, all of which are pleasingly acid. While most folks know that sheep sorrel is edible, few know that it is delicious when served in a salad, or when used as pie filling. Those sorrel pies my mother used to make! No, I don't know how she made them, but she probably applied her good cook's ingenuity to a rhubarb recipe.

There is evidence that "weeds" are creeping back into the civilized man's diet. For much information about weeds as human food, we owe a real debt to some European and American biologists and chemists. There are now a few excellent publications which treat of weeds as food, giving the latest discoveries in considerable detail. Skeptics would do well to get hold of one of these books and then go weed foraging. I'll guarantee him some pleasant surprises. Probably the best all around book on the subject is: *Edible Wild Plants of Eastern North America* by Fernald and Kinsey (Idlewild Press).

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Weeds -- Guardians of the Soil

by Joseph A. Cocannouer

11. Weeds and Wildlife

IGNORANCE of wildlife values on the farm is no more excusable than are our prevalent weed superstitions. Even the songbirds are resented by many, although the birds are among our best friends. Were it not for the helpful birds, insects would soon drive us poor humans off the earth completely, despite our sprays and other bug killers. Then there are the nonvenomous snakes. The childish fear perpetually manifested for these harmless creatures is hard to understand. One garter snake or one whip snake or one gopher snake will catch more mice and rats than sixteen cats. Even a small house snake will put to rout a giant rattler or copperhead -- and get a kick out of doing it. I have watched them. Venomous snakes are cowards and usually have a strange terror of their nonvenomous cousins. As long as there are a few nonpoisonous snakes around the house or barnlot, rattlesnakes are likely to make themselves scarce.

Even skunks are generally looked upon as odorous enemies of respectable folk. More need of understanding. Did you ever watch a skunk digging for insects in a pasture or meadow or orchard? The number of grubs and adult insects that skunks destroy each year is enormous. In the orchard the skunk is especially valuable, since the larvae of many injurious insects are commonly found around the base of fruit trees. Skunks, if not disturbed too often, will frequent orchards continuously and thus do a lot of good by digging up and destroying these fruit pests.

And there is no more ideal sanctuary for all such wild friends than rich coves of annual weeds growing in sheltered spots not too far from the house or barnlot. As I found in that weed cove of my boyhood, our friendly varmints prefer a weed patch to any other kind of cover, especially during the summer and autumn months.

There is an old story of a miserly farmer who possessed extensive orchards and gardens, the only orchards and vegetable gardens for miles in any direction. It was natural for the birds to move into those orchards in droves every spring -- valuable birds and orchards were made for each other. At first the miser only grumbled as the birds went about their business of nest building. But as he grew older, his grumblings

became more threatening. He didn't like the noisy chatter of those birds. Still, so long as the birds didn't disturb his fruit, he'd tolerate them -- and birds were not very troublesome in apple and pear orchards.

To add to his income, the miser planted a cherry orchard. The cherry trees at last came into bearing. The miser was counting a lot on the dollars he would get from those cherries. He visited his cherry orchard daily. The trees blossomed, put on the young fruit -- and the fine cherries began to ripen.

Then the miser received his terrible shock. He went out one morning to find that the birds were pecking his cherries. They had eaten only a few of them, but the miser raged at what he saw. He swore then and there to drive every bird from his orchard. He'd destroy every nest and break every egg.

And he did. It took his laborers several days to destroy all of the birds' nests, for there were many of them. Then the miser kept one man busy for several more weeks, keeping the birds from rebuilding their nests. Finally the birds gave up; went in search of new nesting grounds.

A grim silence settled down upon the orchards and garden then. The miser gloated over his victory -- and the extra dollars he had gained by driving the birds away. He gloated over that grisly silence too. He liked the stillness. He gloated until ...

Until one day he was startled by new and different sounds coming from his orchards and gardens; sickening noises they were -- noises that kept up right through the darkness of the night. Now he was hearing the sounds of gnawing insects! The rasping, crackling sounds caused by insect mandibles! The insects stripped the miser's garden and orchards; then they began on the miser himself. The worms gnawed him; the bugs stabbed him and chewed him. They drove him mad. The miser went out screaming.

There are plenty of adults who need this lesson. Especially those adults who destroy or permit the destruction of valuable birds and their nests, who kill every harmless snake they see simply because it wriggles; or those who think that all the good that skunks do is to stir up a stink. Yes, and those folks who insist on destroying all weeds just because -- they don't happen to understand and appreciate weed values.

Once a very admirable man moved into our Kansas neighborhood. This man bought a sort of run-down farm and then proceeded to improve it not only agriculturally, but also by turning it into a haven for wildlife. And what a contrast was Uncle Les Mason, as we called him, to that miserly farmer! Uncle Les was kind to everybody and everything. He went out of his way to prove to us that wild things did appreciate human friendship. He often told us that the wild things always reciprocated human friendship by helping them at every turn. Why, Uncle Les knew a whole brigade of toads as individuals and called each toad by its name. I remember one jolly-looking toad that Uncle Les called Charley. I was certain that Charley always blinked more

excitedly whenever he heard his name. Uncle Les used to say it was a lot better to have a bevy of toads around to catch the flies than to be bothered with sticky flypaper.

It was Uncle Les's flock of birds that no boy could forget. Uncle Les surely knew his birds and their value as insect catchers in his orchards and fields. But it was the homey things that he made so interesting to us when he was talking; the idiosyncrasies of birds -- or toads or harmless snakes or skunks -- as they went about their daily businesses.

It seems but yesterday when I was trotting at the side of Uncle Les Mason, listening with open ears and open mouth as he pointed out to us the thickets and weed patches that were inhabited by his happy birds; his birds, which he considered as necessary in his very successful farming as were his fat team, his farm implements, and his dog, Rover. I have since wondered why Uncle Les's appreciation of weeds didn't sink home with me at that time. It must have been that I was always too interested in the antics of the birds themselves. Weeds were ordinary, whereas Uncle Les's birds were not.

I can still hear Uncle Les talking weeds, with his fluttering and chirping birds in the dim background. "Fish anywhere you want to along my creek, boys, except at the bends where the weeds are thick," he would tell us. "Don't go into those patches for your grasshoppers -- those yellowlegs are for my birds. They need them to go along with the bugs and worms they harvest in my orchard and garden."

A fair-size creek angled across Uncle Les's farm, and the bends were numerous. In all of those bends were briar and weed patches that during the summer were alive with noisy birds. If Uncle Les ever planted weeds, I didn't know it; but I do know that he guarded his weed patches as carefully as he protected his small patches of grain planted especially for the birds.

Uncle Les Mason is an example of the value of a too-often-neglected side of most theories advanced relative to wildlife preservation: love and understanding for all wild things. The miserly farmer illustrates the value, too, in contrast.

It goes without saying that there must be scientific planning and well-directed procedure, else accomplishments may result in little more than the sentimental hysteria which a bit of superficial knowledge about Nature seems to arouse in so many people. Folks gush over the sublime beauty of redbuds, for instance, then proceed to mutilate the shrubs while gathering the blossoms. Such people haven't the least comprehension of Nature. But stern science, without a measure of sentiment -- true Nature-sentiment -- swings the pendulum too far in the opposite direction. Such naturalists know toads scientifically; they never see the jolly Charleys. They possess the letter of Nature, but too much of the soul is lacking. Anyone who thinks that he must kill a bird in order to study it thoroughly is not a naturalist. He is an anatomist who should work in a museum.

With the present interest in wildlife preservation, we need practical biologists in our schools who can interpret the biology of field and stream and forest -- who are able to read Nature's books. We need a few textbooks or guidebooks that tell the full story about wildlife habits and habitats. While I have not scrutinized all books written on wildlife preservation, I have yet to discover a book or bulletin or pamphlet that gives weeds the place they merit as wildlife feeding grounds and covers. Rabbits or quail or other birds of many kinds -- a weed jungle is an ideal hideout for them. It provides them with protection and food and, in winter, warmth. Of the covers usually found on any farm where there are timber and brushy draws, shrubbery and vine thickets rank first and heavy weed growth second. Grass makes a good cover, but more wild things prefer weed coves or weedy fields than open prairie lands, however dense the grass.

For two seasons I kept check on a covey of quail which for years have made their home near the barnlot. These quail are not often disturbed and have easy access to a dense grass area, a field of either oats or wheat, a spread of fairly thick timber, and a patch of vigorous annual ragweeds. The quail seem to know they are as safe in one place as another, but during the many months I have been watching this flock, rarely have I routed the birds out of the grass. In the hot part of the day in June, July, and August, the birds usually spend several hours in the woody thickets. They also feed part of the day in the grainfields after the grain has begun to ripen, but considerably more than half of the time is spent in the ragweed patch. This, too, when there are no ripe seeds on the weeds. I attribute this conduct of the quail to something more than a partiality for ragweed feeding.

Rugel's Plantain

Quail are partial to ragweed cover because of some benefit they get from the soil where ragweeds grow. Ragweeds do enliven the soil. The soil where thick prairie grass grows is also richer than that found in most cultivated fields, but in sod it is not so easy for the birds to get close to mother earth.

Which brings us to one of the most tragic causes of wildlife depletion in many parts of our country: soil sterility. The garden toad, once so familiar around the doorsteps almost everywhere, or in the kitchen garden, or milk house near a cool spring, is now rare. A short time ago I visited my early childhood home in Kansas. I went first to the now-deserted cottage; the little house that had been home to me so long ago. I remembered the toads that had lived in or near our cool cellar and around our wonderful oaken-bucket well. I searched for them, but there was not a toad to be found.

Then I went to call on a friend of those yesteryears, a friend whom I had not seen since those days of my early youth; those years when we both cut weeds for Sol Benson and others. And I mentioned not finding any toads in the spots where they had

once been so numerous.

A reminiscent shadow slid across my friend's face. "Toads! I recollect how thick they used to be when we were kids. Fly-catchers, we used to call 'em! I don't remember seein' hardly any toads for thirty years or more -- "

The everyday life of the humble toad is tied in with soil fertility. The toad is more dependent on fertile soil than many other wild things familiar to us: rabbits, gophers, skunks, and snakes. Toads haven't a great many enemies among other wildlife. Even snakes don't care much for toads. But toads soon disappear from land that is weak in organic substances, though the insects on which they feed may be plentiful. Earthworms and toads -- their absence spells weak or depleted land.

Throughout the United States some species of birds have become rare for the same reason: our eroded or exhausted soils are not providing birds the nourishing foods which for many of them are essential. On eroded land even weeds do not produce high-quality seed for the seed eaters. Granted that many other factors share responsibility for the depletion of our valuable birds, low-quality grains and the persistent destruction of weeds have, either directly or indirectly, taken a heavier toll than is usually recognized.

Whenever I visit a weed cove, which is one of my chief outdoor sports, I inevitably compare it with that one particular cove of my youthful years. That cove was wildlife at its best. In summer or winter the cove was activity plus. In it, many wild things found food, either insects or seed, and protection and warmth, preferring it to the surrounding rich fields and meadows and forest in which food was abundant.

Such weed coves are not often found now. Where there is continuous erosion the water often sweeps through the coves and disturbs the soil-mellowing work of the weeds. Either poor soil is washed into the coves, or the dead plant bodies are carried away. The weeds may struggle along and make a fair growth, but they are not able most of the time to build up a rich, mellow earth.

Dense shrub thickets provide a bit better cover than weeds, since these thickets are more permanent and enemies cannot penetrate them so easily. A wise farmer, instead of destroying his thickets, will encourage them to grow in all places where land can possibly be spared. And not all of the thickets should be located in pastures. The best wildlife thickets are those completely isolated from all farm activities, located where domestic animals cannot browse in or near them. Permanent weed coves should be left as undisturbed jungles.

An ideal setup for many species of wildlife is a dense, well-shielded thicket that stands near a small field that has been released to weeds. I know an almost impenetrable plum thicket situated near such a weed patch. The weeds in the small field have been permanent fixtures for only a few years, but even when that field was under cultivation there usually was a good growth of weeds in it late in the summer

after crops had been laid by. This plum thicket and field have long been a favored spot for migratory birds. Many species have for many years spent a part of each year here, some for only a few days, while others have come down from the north to remain for the winter.

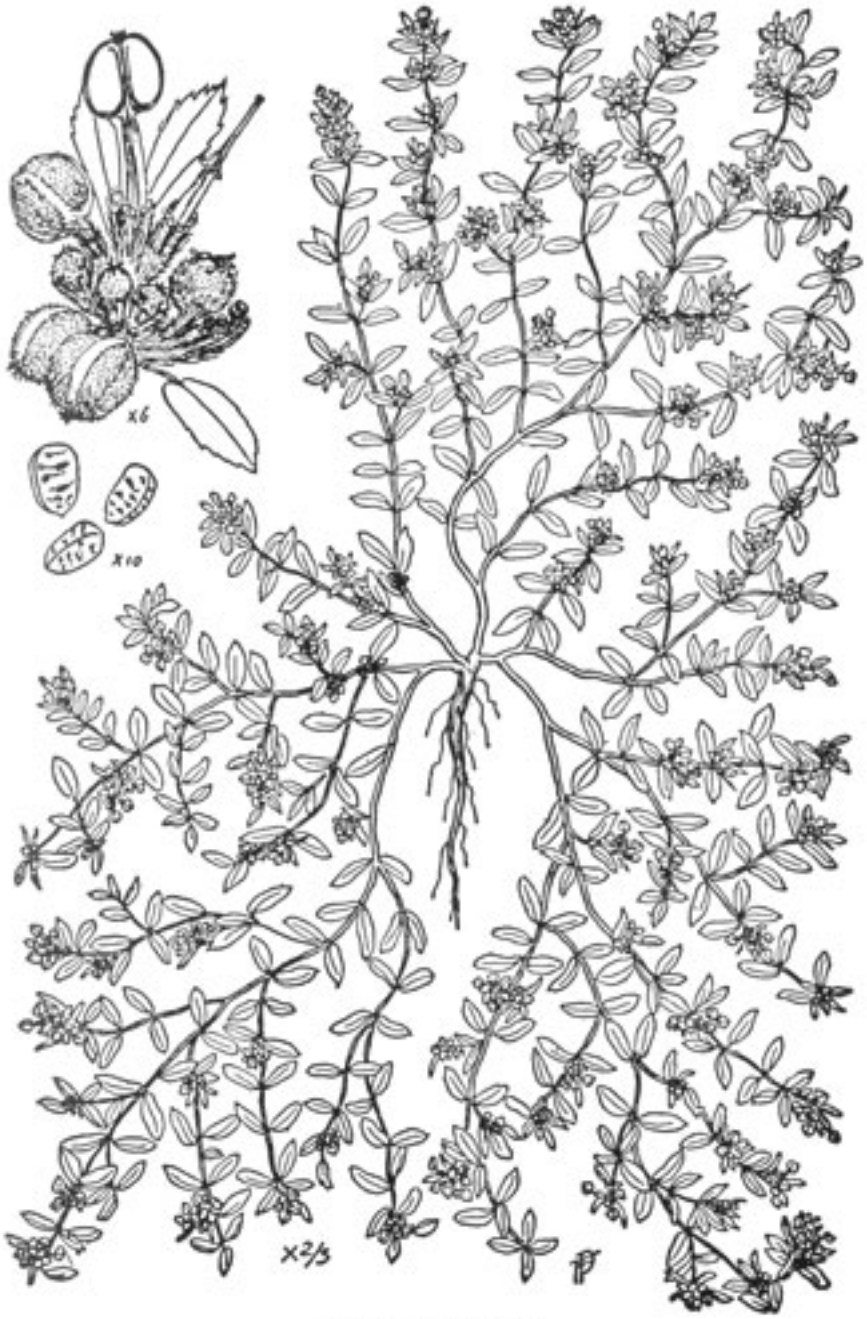
During late years, though, the bird population of this thicket has shrunk to a mere fraction of what it formerly was. I am quite certain that the birds haven't shifted their course. The birdlife has vanished in direct proportion to the depletion of the farmlands.

Just lately I watched from a concealed spot the activities in and around this thicket. I had seen some migratory birds near the house, which immediately brought the thicket to mind. I found a few migrants in the thicket in addition to the two or three species of small birds that make the thicket their permanent homes. But the migratory birds were few. In an hour I saw only two species, and I could have counted all of those on the fingers of my two hands and had a finger or two left. I decided to go out into the weed patch, hoping I could in that way add more visitors to my count. But at that same moment I caught sight of something that caused me to change my mind: a wild house cat. The cat was easing its way towards the thicket, bird hunting, of course.

The prowling beast soon disappeared into the brush. Immediately birds came fluttering out. I ran to the thicket and routed the cat, after which I said a few uncomplimentary things about people who cast off their cats to hustle for themselves. One can't blame the starving cats. But why can't people put the cats out of their misery and thus save a very large number of valuable birds?

Cats may be questionable pets; they don't help to produce and conserve food -- save for an occasional worthy mouse catcher. Birds do. One spring I kept a record on a pair of friendly wrens that had built their nest in an old bucket near my garage, which stood near the garden fence. For four uninterrupted hours I checked the number of worms the birds brought from the garden to their five young: every forty-five seconds one of the birds returned from the garden with a worm! I know, because I timed them carefully with my watch. I was a wreck when I finally gave up. And that wasn't all: those faithful little laborers had been at it since daylight. I have no doubt they continued their work until dark. Where those tiny nestlings put all those worms is still a mystery to me. But I am very certain those two wrens were largely responsible for some excellent cabbage in our garden that summer.

While wrens as a rule do not frequent weed patches, many other valuable birds do: for seed or for insects -- or just for cover when they are not busy elsewhere. If two wrens in a few hours could do so much valuable work, think of the good all birds taken together must do. Then add to this the joy they bring us in friendship and song.



Spotted Spurge

The 4-H club work, dealing with wildlife preservation, is a grand movement and should receive hearty support from everyone. However, there is danger of this work's becoming too mechanical. Boys and girls should be taught in school and in club meetings that the first step in learning how to preserve the wildlife is to learn to love the outdoors -- and to understand the outdoors. They should be taught how to study the wild things in the fields and forests -- and weed patches. In this way they can best learn the relationship that exists between the birds, for example, and man's well-being. In this way it will be possible to present to the boys and girls the sentiment factor more realistically, for to see wildlife in action in the field will teach more than whole libraries of books.

As the young naturalist systematically studies his wild friends -- and they should be

looked upon as friends even though they do scamper away when he approaches them -- he will often find his path leading straight toward a weed patch. And he may be a bit surprised to discover that so many of the inhabitants of the big outdoors depend upon weeds for food and shelter. From then on, as a true naturalist, he will see weed coves in a new light. Weed patches, with their seeds for his valuable bird friends; weed patches for cover for other wild things -- they all belong together. And all are man's trustworthy friends.

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Weeds -- Guardians of the Soil

by Joseph A. Cocannouer

12. Sponge Structure versus Dams

PROBABLY no other region of the United States has experienced such evolutionary changes as has the Mississippi Basin. And practically all of these changes have come about since the arrival there of the white man. To the Indian, that vast expanse of territory drained by the Mississippi and its tributaries was second only to the Happy Hunting Ground. And the early explorers agreed. At any rate, they sent word back to their friends and relatives in the original colonies that they had indeed found a paradise on earth: rich land without measure for all who wanted to come.

And they came. The machine-minded white man pillaged the wealth of the Valley: forests went into lumber -- or up in wasteful flames and smoke. In due time the prairie lands and erstwhile forests were pouring forth food crops beyond anything believed possible when the land was first broken.

More decades went by. The day arrived when the Great Basin came to be called the granary of the world. Cities, as if they too were growing from planted seed, sprang into being to process and utilize in various ways the soil's wealth. Major interest began swinging from the *production* end to the *factory* part of agriculture. The making of good flour was more important than growing superior wheat.

Even so, during most of this second phase of the Great Basin's history, farming methods were basically sound, save in one vital respect. The inexhaustibility of the soils of the new continent was still taken for granted, as it had been since the landing of the Pilgrims back there in New England. Science entered into farming in a grand way -- above ground. We built our agricultural superstructures efficiently. Livestock was developed to meet every special need; farm machinery by now was coming from the factories in an endless parade, each machine an improvement over its predecessor, and each machine improving the *mechanics* of farming.

It was during this period, too, that plant scientists performed wonders for the Great Valley. Among these wonders were disease-resistant grains that also gave double

yields; fruits that the Pacific Coast alone could excel in; protein-rich forage crops adapted to almost every type of soil and climatic condition. Though little thought was given to land conservation, the land continued to produce bountifully -- and we harvested. We mined our soils to the limit. We ignored Nature's law of return compensation, though even at that period Nature sounded her warning.

And it has been our persistent ignoring of that law of return compensation that has brought us to the third phase of the Basin's history: the period of rapid soil depletion. We are deep in that phase now. Long since have vanished those streams, almost clear even in flood, which were common in pioneer days; no longer do we have unsilted riverbeds. Instead we find ourselves with all rivers and all smaller streams overflowing with soupy-thick water after every moderate rain. Now we have broad stretches of denuded slopes and upland farms with weak and unbalanced surface soils. Much of our once-fertile bottom land is now spread with mediocre soil, and that soil is still pouring down from the poor uplands.

And then there is the harvest! Unbalanced food products are now being gathered from most of the food-producing land in the Basin. Many food specialists and other scientists tell us that such a large percentage of our farms are now turning off unbalanced foods that deficiency diseases, once rare, are more and more lowering the health standard of our nation.

Erosion, the chief cause of land depletion, is still going on, and savagely. Where erosion is not a serious menace, we have mined our soils instead of farming them intelligently. Blindly we have destroyed the original sponge structure. Blindly we have refused to recognize Nature's law of return. Today the Great Valley as a whole presents a superficial picture of opulence and progress; internally, from the standpoint of a stable agriculture, the foundation is tottering.

There is enough sediment resting on the floor of the Gulf of Mexico to build a sizable continent. Where did it come from? Practically all of that sediment came from the farms of the Great Basin. What has not gone on to the Gulf has been deposited in riverbeds, or has gone into building swampy deltas. Our riverbeds, once deep, are shallow. Overflows are inevitable. River-bottom lands, once among the most dependable food-producing areas of our country, are practically valueless in many sections.

The fact that there are areas in the Great Basin where constructive land management is being carried on, does not change the drab picture to any degree. The small amount of improvement that is being accomplished here and there is insignificant compared with what needs to be done.

In traveling across the country one now and then comes to a region where, at first sight, practically all of the land seems to be under improvement. A friend told me about such a situation where he was so impressed by the amount of conservation work being done he decided to go back and make a thorough recheck in order to be sure he

hadn't misjudged. He received a shock. Actually, not more than a fourth of the land was being given constructive treatment. He was there during a heavy rain, when he had a chance to see erosion at its worst: neglected pastures almost carried off in chunks, he said; abandoned fields dissolving before his eyes; small, inconspicuous spots tumbling into the deeper gullies -- and vanishing as red water. All of this added up to three times the land under improvement. If such was the case in a progressive area like that -- what must be the picture of our country as a whole!

But the very fact that we can rebuild -- are rebuilding to a degree -- gives reason for considerable encouragement. I have seen some very satisfying illustrations of what can be done in the way of transforming stiff subsoil into a new and highly productive surface soil. I have seen land approaching the original prairie soil in fertility, all rebuilt solely by adhering strictly to Nature's laws of land building: by filling the soil with the right kinds of organic materials and in the right way. I have watched the rain pour down on such land -- *on a slope*. The rain immediately went into the ground. That soil had its dams -- a tiny dam for each drop of water. It had its *sponge structure*, which is the only logical reservoir for controlling erosion.

A true soil is one that is so friable and mellow it absorbs rainfall much as a blotter takes up ink. When a soil is properly filled with organic materials -- disintegrated and disintegrating weeds and other herbaceous plants, fallen tree leaves, decaying straw, and so on -- the whole soil mass becomes a huge sponge. Such a soil can drink any except the heaviest rain as fast as it falls. That is why there is little erosion where Nature's virgin soils are still found, unless the land is extremely steep. Even in the latter situations the runoff is normally not great. And all because the land has the essential sponge structure developed through the inculcation of organic materials.

Only through the refiberization of our lands on the slopes can we hope to protect the lowlands. Small frog-pond reservoirs up near the sources of the streams, or near the mouths of the smaller tributaries, should do considerable good; but river embankments and dikes, though necessary in places, are as a rule only temporary expedients. They are just a continuous enlargement of the trough to hold more of the runoff silt. And the runoff will continue to pour down its silt until the runoff is checked before it starts. Raising riverbanks higher and higher and thus lifting the river higher and higher above the bordering lands, may be good engineering -- it is not logical soil conservation.

I cannot help feeling that if the people in our Great Basin were brought to see how serious our soil situation is, they would respond with greater determination than has been the case up to now,. It is true that most folks do not like unpleasant facts; but here is one important fact that directly affects all of us: at our present rate of land waste, there will be little productive soil left on the Great Plains forty years from now. This statement is not a guess; it is backed up by reliable soil surveys, Dams, no matter how colossal, will never stop runoff . And they will not build back what we have already lost.

Only an aroused public can stem the erosion tide! One important way we can help is by getting solidly behind the soil-conservation service of the United States Department of Agriculture, which is doing some excellent work -- although it isn't in all cases building sponge structure as rapidly as might be desired. Erosion and incorrect farming methods are tearing down faster than the conservationists are building. We need more conservationists on the job. We can use more spade work and a little less show and tongue work. We need to take a few lessons from the subtle agents of erosion themselves: ceaseless persistence, and silence. Depend on it, we'll never lick erosion by any other means.

There seems to be no valid reason why every county shouldn't be organized as a unit, with everybody given a chance to become a part of the unit. Where counties are already organized -- as a great many are -- the county organization should be expanded to include everybody who will agree to help build soil, and then given a bit more efficient directing than is the case in some places. Let's get everybody on the job. Then let's make sure that the major issue is putting sponge structure back into the land -- in a practical manner. Let us build sponge structure until every acre in the country drinks the rain as it falls. That'll call for sweat and a lot of it -- but an acre healed will mean an acre gained; possibly several of them.

And every little bit does help! I had a good illustration of this not long ago. A man who had listened to me discuss weed values on several occasions decided to try out weeds on a tiny bit of eroded land that lay behind his house. This area of only a few square rods was peeled and gullied -- about as poor, he told me, as land could be. His original plan was to help weeds get a start on the piece, then thin the weeds and use them as a mother crop for something, I don't recall what, that he aimed to plant with the weeds.

He scratched the surface a bit, then scattered over it some rotted manure that he gathered up from a part of his corral, where an assortment of weeds had grown luxuriantly for several seasons. This manure, of course, contained an abundance of weed seed, and the weeds popped up, he said, like all get out. Then something happened to prevent his getting round to planting his companion crop; the weeds were left to go it alone and without any disturbance.

One day when it was pouring rain, he decided to go down and see whether or not his weeds were holding back the runoff. The man admitted he was skeptical when he left the house, for it was really raining. And he remembered how many years the water had been gushing off that little slope. But when he reached the lower edge of the slope, he found, much to his surprise, that only a small fraction of the water he knew was falling was making it through the weed patch and pouring into the small brook. The weeds had already built up a sponge structure efficient enough to catch and hold the rain.

Fortunately there are many ways by which the sponge structure can be put back into

our hungry and depleted soils. The case just described was simple, yet a good one. These sponge-building operations would seem to fall logically under three heads, each more or less demanding its own system of treatment. First, there are those tiny areas which, at first thought, would not appear to amount to much: the eroded nooks and washed spots on most farms, like the one mentioned above; the small garden areas, including town and city gardens. The sum total of these small areas adds up to a much larger acreage than one would at first suspect. While most rardens are fairly well cared for and are not affected seriously by erosion, many gardeners do have the erosion problem, even in town.

Establishing a good sponge in garden soils not only assures water absorption, but it also enhances soil balance and guarantees quality produce. To fill the soil with barnyard manure or well-built compost or green manure of any sort; to fiberize the lower soils with deep-diving weeds is always good business.

Then there are those discarded or semi-discarded areas that now spread across our country: abandoned farms or parts of farms; denuded forest land; rocky sections;. countless sloping acres which as they now stand are next to worthless. A large percentage of the wild pastures falls into this class. Someone has said that if we could stop erosion from these eye-sore areas, our erosion problem would be well on its way to solution.

Apparently about the only way we have of getting such land covered with holding vegetation is for state and national governments to take over completely. It seems impossible for farmers to take personal interest in such projects, with the exception of a pasture now and then. Most farmers figure that they have all they can do to look after the land that must fill their breadbaskets. Maybe a cooperative scheme between government and farmer can be worked out that will get the job done. Certain city and town organizations might well get in some constructive licks here -- for erosion is very decidedly a menace to all of us. Going to the country and helping farmers to build sponge structure could hardly be called philanthropy. Anything that any of us can do to get our unused land covered with vegetation will be stabilizing our own future as well as that of the other fellow. And the fine part about it is that this work could practically all be done without technical skill. All it needs is progressive leadership.

The third and, of course, the most urgent need right now is the building up of our food-producing soils. We should be pouring into this land green manures, barnyard manures -- every type of organic material that will decay in a reasonable time. The method of getting this stuff into the soil and getting it at work will vary with almost every locality. No set rule can be given that will apply to all sections -- except that the materials should be poured into the land as fast as conditions will permit, and that we should keep pouring them in until the sponge is there, much as it was when the land was broken up.

In most of our soils it will require enormous amounts of the right kinds of materials

before there will be any noticeable betterment of conditions. It will be wise to keep that in mind. There must be many crops of lush legumes, the latter inoculated in most instances. The green stuff should be thoroughly broken up and then wilted before being turned under. That will hasten their transformation into fiber. Green manure will need to be grown on the land every possible season of the year, even though that may at times mean the sacrifice of some other crop. Lime will often be necessary and rock phosphate advisable -- but high-powered stimulants will not help build sponge structure except where the land is so poor it needs a quick perk-up to start things off. We need the help of the active soil life in maintaining our sponge, and stimulants are likely to kill or drive out that life.

So much for our surface soil. It will take something more to care for our subsoils completely, and those deeper soils need fiber also. We need to establish as large a sponge volume in the soil as we can. To do that we will need to employ our deep-diving weeds. Too much is at stake for us to permit weed superstition to rule our actions. The weed roots will build little dams down in the deeper soils -- millions of little dams placed exactly where they should be. A regular weed crop in a well-planned rotation will convince anyone of that -- if he is willing to be convinced.

If the cost of just one colossal dam could be used to build sponge structure in the areas where the erosion menace is worst! We should bombard our senators and congressmen with demands that the huge dams be postponed -- save possibly in the Far West, where irrigation water is vital and the silt in the feeding streams no serious menace -- until we get the sponge structure job well under way. Let's work for more support for the conservation division of the USDA. This support should be something more than what the government is able to do financially, however. We have no moral right to expect the government to bear the whole burden. We have a lot to do individually in every community. We need to get out and reveal the old American spirit that seems to be vanishing from our blood. Our forefathers were builders, even if they did shoot off at the wrong tangent here and there. Again let us manifest that building spirit; let us all become soil builders, even if some of our individual parts may be only a few square yards!

Then let's give our farm youth a chance to carry on sponge-building projects; offer worthwhile prizes. Rebuilding a piece of sloping land may not be as simple or as thrilling as growing and finishing a prize-winning steer or hog, but rare is the farm lad who would not be willing and ready to take on the job if his leaders were ready to direct him. Every dollar spent in this manner would accomplish more than every hundred spent in building large silt-holding reservoirs.

There is no argument against dams and reservoirs at the right time and in the right place. Irrigation water in many parts is vitally essential, and hydroelectric power has become indispensable to all of us. Of course, it is a bit difficult to reconcile oneself to the valuable acreage buried beneath some of the large reservoirs -- with our uplands depleted as they are. But runoff is a danger which great dams do not prevent -- even though the dams may be built where little cultivated land is lost. And stopping

wasteful runoff is our number one agricultural problem. We must stop that runoff before it starts, by putting the sponge back into our soils. Naturally, it will take a much longer time to fill a reservoir when the soil sponge is returned, but when full the reservoir will contain water and not one-time farms.

En fin: the good farms buried by the lake will not loom so large in importance -- *if we first rebuild our food-producing uplands before we build our dams*.

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Weeds -- Guardians of the Soil

by Joseph A. Cocannouer

13. Here and Yon

I ONCE received some valuable weed knowledge from a former secretary of state of the first Philippine Republic. The old Don's hacienda, where I first met him, lay very near the land on which we were establishing an experiment station, and he owned some land which we wished to annex to the station. This land was already planted to young coconuts, and was just the thing, we thought, on which to demonstrate the *right* way of growing coconuts. We Americans out there at that time didn't know much about the right methods of growing this famous palm, but the ex-secretary was considerate of my lack of coconut wisdom, as he was most graciously patient with my limited Spanish.

After the usual bit of courtesy talk with the Don, my native assistant, acting as interpreter, delivered to me the good news that we were to be given the lease on the land for a period of ninety-nine years.

"Fine! " I said, gasping at the ninety-nine-years part. "Thank our generous friend -- now what are his terms?"

Then after a few more minutes of excited palaver -- "The Don say we may have the coconut plantation to do with as we wish, except he ask that we do not cut the weeds that are growing with the palms!"

I really did gasp at that. But after answering for me a barrage of questions which I immediately began hurling at him, the ex-secretary revealed convincingly that he really did know his tropical weeds in their constructive relation to coconuts.

The roots of the palm, he explained, are long and slender and like to feed close to the surface of the ground. He said he had long ago learned that when the roots of the coconut palm are not able to feed very near the soil surface as well as deep in the soil, the trees do not make the growth they should during the earlier years. In the torrid zone, where the rains are extremely heavy, any except a very sandy soil, unless

protected by vegetation, is likely to form a thick crust that will not permit the proper functioning of the coconut roots. For that reason, the Don did not like clean coconut plantations. Also, he said he had discovered that the palm roots grew well among the weeds, excepting where the weeds were very, very thick. Years of experience had convinced him that weed roots and coconut roots were not enemies of each other.

It was important to keep the ground clean for a meter or so out from the base of the young trees so the palms could get the necessary ventilation and sunlight, but it would be quite all right to cultivate a strip of land midway between the palm rows. All that the ex-secretary was asking was that we permit the weeds to grow everywhere else.

I accepted the land under the stipulated conditions. But after the old Don had returned to the village and I had sent my assistant about his work, I kept right on sitting there under the mango tree, living over that long-ago talk back there in Sol Benson's cornfield.

Sol Benson and his pusley; the wise old Filipino Don and the weeds in his coconut plantation -- almost the same situation, though ten thousand miles apart. There were all sorts of weeds growing in that young coconut grove: annuals and perennials -- I cannot now recall the name of a single one of them. A matter of minor importance. But it was important that Sol Benson and the Filipino planter had talked to me about weeds in the same manner: what weeds would do when growing with farm crops.

And then I remembered: actually, corn roots and palm roots are very similar in their feeding habits. Sol Benson was certain the corn roots accompanied the weed roots into the lower soils. The palm roots were likely doing the same thing in the coconut plantation. The American farmer and the Filipino *hacendero,* though many years of time separated them, had each discovered a fundamental weed value: Sol Benson, that weed roots opened the soil so that crop roots could feed deeper; the Don, that unrelated root systems grow better together than when either is growing alone. Each had glimpsed one of Nature's vital laws that govern the soil world.

Some of our own weed friends work well as companion or mother crops, as the Don discovered with his tropical weeds, while others serve best as green manures. There are those that are good divers into stiff subsoils, and those that seem to prefer the loose gravelly subsoils. Then there are those weeds that make particularly good cover for most kinds of land. And the edible weeds: those that make the best livestock forage, and those that are good food weeds in general. Much must still be learned about the whole of weed values before any individual weed can be placed definitely where it will render the best service. Most of our common annuals seem to have several constructive uses. In the discussions that immediately follow, effort has been made to present a bit more information relative to the *specific* uses for most of our particular weeds, based not only upon my own findings, but also upon the findings of many others who have employed or are now employing these weeds successfully.

I usually think of the pigweed first as a general, all-round weed. There are several species of pigweeds, including the tumbleweed as well as our ornamental coxcomb. They are all annuals and native to America. I am here interested especially in the redroot, coarse-leaf variety, though there is a smooth-leaf strain that is about as good. This weed may be found growing in cultivated fields as well as in waste places. It is deep rooted and an excellent soil improver if correctly managed. Aside from being a first-class mother weed and an excellent green manure, it is a worthy potherb and good for making hay or ensilage. Its scientific name is *amaranthus retroflexus.*

Lamb's quarter is also a good weed, fitting into about as many niches as the pigweed. It is an annual and a native of Europe. As a general rule, lamb's quarter may be found wherever pigweeds grow, and often as a companion of giant ragweeds. This weed is a good diver and brings up much food material to the surface soil. It is an excellent green manure and makes an ensilage second to none when mixed with legumes. It is also a good mother weed if controlled, and one of the best potherbs of the whole group (*chenopodium album*).

Then there are the two annual ragweeds, both friends of the land wherever they grow. Both the giant (*ambrosia trifida*) and common (*ambrosia artemissifolia*) are native to America. The common ragweed needs no introduction to anyone -- it is almost everywhere. The giant ragweeds, or horseweeds of the middlewest, are a bit more exacting, preferring edges of cultivated fields, open forest areas, or sunny coves where they can grow unmolested. But this weed will also take hold in hard land. It often reaches a height of seven or eight feet where the soil is fertile, and it may be easily recognized by the abundance of pollen which it scatters when in bloom. The common annual ragweed will produce a crop on the poorest of land. Neither of these two valuable weeds is used as human food. The lower animals go for them, though. Cattle seem to eat green ragweeds as a "vitamin"; and quail and other birds relish the seed. Some farmers who have tried it consider ragweed hay excellent forage. The giant ragweed has been used successfully for making ensilage. It is probable that one of the most important uses of the giant rag is to provide seed for many kinds of birds during the winter season, when bird food is scarce.

Our native annual nightshade deserves a high rating. This nightshade may be recognized by its white flowers, which resemble those of the potato, and by its black, berrylike fruit. This is a clean weed and works well for most row crops as a mother. It has a penetrating root system that forages well in the lower soils, and its spreading habit of growth makes it a good soil protector (*solanum nigrum*).

Then there is the milkweed, shunned by most folks because of the weed's milky sap. I have just read a Johnny-come-lately article recommending milkweeds as superior potherbs; the Indians knew that before the arrival of the white man in America and taught our Colonial ancestors its value. The milkweed is a vigorous-growing perennial, with a root system that wanders far from the base of the mother plant. There are several strains of this weed, each more or less preferring its own soil and

location. Rarely is there a field or pasture where a variety is not found. Milkweeds are not soil robbers! I have yet to find a case where these weeds gave even superficial evidence of being harmful to the crop with which they were growing. Most milkweeds will take hold on extremely poor soil if assisted a bit, and do a good job of opening it up (*asclepias syriaca*).

And now the sow thistle -- which is not a thistle at all; it is a wild lettuce. And it is far from being the noxious weed that some weed books would have it. The sow thistle is a native of Europe and made its way over here very shortly after the Pilgrim fathers. It is now a common weed in gardens and fields and in waste places in most communities. It companions well with most row crops, since the roots feed deep after the plant is once established. The sow thistle will often grow a fine crop of green manure in the fall, a point especially in its favor (*sonchus aleraceus*).

And the pusleys. The succulent purslane of my boyhood years -- and Sol Benson's cornfield. Purslane is a wonderful soil covering, but not easy to induce to take hold on extremely poor land. It needs fairly good soil to start it off, and that is why most farmers familiar with purslane consider it an out-and-out robber. Once established thinly over a field, the roots of the purslane gather much rich food material in the subsoil and bring this to the surface. And as Sol Benson found, the pusley opens up the ground for the corn roots, or for any other crop with which the weed may be growing. Purslane can be readily recognized by its reddish succulent stems, which lie flat on the ground. It is a native of Europe and an annual (*portulaca oleracea*).

The other types of spreading weeds differ very materially from purslane. Most of these spreading weeds belong to the spurges, of which there are many. Spurge likes to grow in hard ground, often forming mats in a traveled path. I once made a study of some of this spurge that insisted on growing in the middle of a well-traveled road. It is amazing what the roots of spurge will do to hard soil. I found the soil for several inches out from the weed base to be soft down to a foot or more. Where there were none of these weeds, the soil was stiff, hard clay. On severely eroded land the spurge certainly has a place. It may be hard to get started, owing to the difficulty of collecting and planting the small seed, but once established it will go it alone. The common spotted spurge (*euphorbia supina*) is a native North American annual.

Here I must introduce a good friend, the annual ground cherry, not because it is a superior soil improver but because it is such a clean weed in either field or garden. There are many strains of ground cherries, a few of which are perennials and consequently do not fit well into the rotation nor grow well as mother crops, as do the annuals. All of these weeds produce their fruit in a sort of capsule. The annual ground cherry, because of its bushy habit of growth, is a good soil shade aside from the value to be derived from its deep-feeding roots -- and its fruits which make the *right* kind of pies. I have seen these ground cherries taking hold on the poorest kind of land, which indicates their possibilities as conservationists (*physalis subglabrata*).

And the goldenrod (*solidago*), good for either gravelly or heavy soils, depending upon the variety. Some goldenrods seem to prefer stiff soils, though as a rule the tribe seems partial to the sandier land. Not long ago I found a piece of very heavy land which the goldenrod was doing a good job of fiberizing. Since goldenrod produces an abundance of seed, it should not be overly difficult to put the weed to work on peeled land or along the brinks of gullies.

Then there is the despicable cocklebur, possessing, like some humans, a few virtues despite its many bad traits. The cocklebur is one of our most persistent native annuals. By including it in this list of perfectly decent weeds, I do not mean that it should be planted on any kind of land. But farmers often have cockleburs in their fields, whether they like it or not. And it is good sense to make use of them constructively. Cockleburs will often do wonders to obstreperous soil if they are thinned enough to permit normal root development. Whenever the plants are scattered thinly throughout the field, cockleburs are not bad companion crops. Many farmers can tell you that corn and cockleburs go it well together (*xanthium commune*).

The familiar sunflower is a weed whose value to the soil is rarely appreciated. Sunflower value comes not only from the weed's ability to forage well in the deeper soils but also from the fact that the stalks, when broken up and turned under, disintegrate rather quickly. The amount of fiber added to the soil by a heavy crop of sunflowers, not to mention the abundance of plant food which these plants provide, will come near doubling that of any other green-manure crop. The sunflower is an annual and as truly American as the Indian (*helianthus*).

There are times when a most insignificant weed is able to prove its worth to the soil in a very conspicuous manner. Not long ago I came upon such a case; a case where annual smartweeds (*polygonum hydropiper*) were doing a good job of draining land. Of course, I had always been familiar with smartweeds. Mother used them to make brine for her pickles -- and kept me on the jump hoeing them out of her Kansas garden. I had long known that this weed also grows where the land is boggy or poorly drained. The patch of smartweeds I refer to here was growing on a strip of very tight land; eroded land that had been crudely terraced and then left to go its own way. Because of the impervious condition of the soil, rain had formed pools back of the ridges, and most of this water remained there until it evaporated. But where the smartweeds had taken over, the smartweed roots fiberized the soil and thus provided for natural drainage. Many farmers have just such conditions scattered through their fields. I mean those low, tight spots where water stands for a long time after a rain. Smartweeds might come to their rescue here if they were to give the weeds a little help. Annual smartweeds are not difficult to eradicate once one is through with them.

And do not forget that the annual wild morning-glory (*ipomoea*) is not a bindweed (*convolvulus*), though the two are relatives. The annual morning-glory, another native American, is really not a pernicious weed. While these morning-glories should perhaps not be planted in fields that are regularly cropped, if they move in of their

own accord they should be controlled and thus forced to serve as a valuable mother weed. And morning-glories will do a good job on extremely poor land; that is, land that is suffering from a lack of soil fiber. Many farmers know that corn and these morning-glories get along well together.

In addition to the weeds discussed, there are a few others that deserve mention, though they may not be outstandingly beneficial from a soil-building standpoint. One of these is the common wild lettuce (*lactuca canadensis*), a familiar roadside weed and one which has the ability to penetrate hard soil almost as well as the famous legume, sweet clover. And the shepherd's purse (*capsella bursapastoris*), a member of the mustard family. The shepherd's purse makes a fairly good winter green manure in some southern sections. Then there is the dandelion. The dandelion may be a pest in the lawn, and in some parts of our country in the field, but in most regions it makes a good mother crop in either the garden or field. In England dandelion is ranked high as a soil-improving weed.

There are many wild legumes, most of which are friends of the soil. These include some of the lupines, the button and burr clover, and the wild vetches and peas found in so many parts. Many of these will grow excellently with non-leguminous weeds, and in the weed-legume combination in land building they surely have a place.

"Yes, but supposing I decide to use weeds in building up some of my poor land -- how do I go about it? This land I'm thinking about is worn out -- dirt plumb gone. Most of it, anyway. Not many weeds on it either -- they won't grow there. Now how am I going to make 'em grow?

When folks start asking those questions, I know they are becoming weed conscious in the right direction. It is true that much of our once-rich farmland is so poor that practically all of our soil-building weeds refuse to make much of a growth on it. In most such situations the weed seeds are there and the seeds germinate, but the seedlings soon die or, because of a lack of nourishment, make little growth during an entire season. They are too weak to reach down into the lower soils.

Here is one place where I heartily approve of the application of some strong stimulant to the land -- to give the weeds a boost during their early stages of growth. By working a small amount of some concentrate (almost any of those now being so highly advertised) into the soil, and then broadcasting the weed seed over the land after the soil is settled well, a good growth of weeds often may be obtained. However, there are situations where even an elixir won't do much in the way of starting the young weeds off. But where it does work, it will keep the weeds going until they have strength enough to forage for themselves.

In planting weeds, a farmer must keep in mind that weeds are very decidedly *weeds.* Which is to say that their habits are wild. The seed should be scattered over the surface of well-packed or hard ground, not on land that has been freshly plowed. The

best time to plant weeds is just before or during a rain in early spring, or in winter when there is snow on the ground. Scatter the seed over the snow and forget about them. While many weeds, such as sunflowers and lamb's quarter, plant easily, some of our best weeds are unpredictable. If they don't grow the first time, you may have to "try again" several times.

Bringing a piece of land back to permanent fertility is probably the most difficult of all farm operations. Too often the farmer fails to make a go of his soil building because he doesn't acquaint himself thoroughly, before starting, with all the adverse factors he is going to have to fight. He gets discouraged because he does not see the size of the job of remaking land that has been weakened for fifty or a hundred years. He has more than likely been schooled to expect the quick response that land makes to stimulants. He forgets that now he is *building* for permanency, not merely *stimulating*.

Remember: it takes Nature, working from scratch, from five hundred to a thousand years to build one inch of fertile, perfectly balanced soil. If the land builder would always keep that fact in mind, perhaps he would not want to give up so quickly when he cannot see the slightest progress in his labors. Not, of course, that he will have to struggle for years and years before seeing beneficial results. But to complete a good soil-building job calls for much sweat and time. The valuable work is going on under the surface, but signs of this are often slow in appearing above ground. Only stimulated land, as a rule, will reveal spasmodic responses.

There are really only two vital factors connected with land improvement once the mechanical work has been completed: lime application in practically all cases, and rock phosphate in many of them; and filling the soil with organic materials so that these may be in the soil at all times and at all stages of decay. On very poor land much of the first application of lime is going to be lost, and there isn't much the farmer can do about it. In depleted soils there is no sponge structure. Unless the soil happens to be extremely tight, a very large portion of the lime will be lost through leaching. Yet there must be ample lime at the beginning else not much of a green manure can be expected, especially where legumes are employed. And it is the green manure which must furnish the fiber to rebuild the soil sponge. The green crop also provides the food for the other agents of the soil world that are waiting to move in.

Getting the sponge structure may prove a difficult task, yet rebuilding that sponge structure is very close to the whole of land improvement in the United States today. Not uncommonly, even after two or three excellent crops have been turned into the soil, the land does not reveal any change for the better. At this point in his work it is well for the farmer to pause and try to recall just how long that particu.lar piece of land has been under cultivation. Maybe fifty, maybe a hundred years, and the soil has been deteriorating all of those years! A farmer can in many instances consider himself fortunate if he sees any marked change in such land short of six, eight, even a dozen green-manure crops, although there are often situations where the subsoil is such that

it is possible to build a good surface soil from it with only three or four lush crops. Often it may be advisable to give a second and light application of lime after the land starts to show signs of real mellowness. That means there is probably now enough fiber in the soil to hold the lime.

The farmer will generally find that his best bet is to work with mixed green manures. He may have to try out several legumes before he finds the one or ones best suited to his situation. In all events, he should strive to keep a soil-improving crop on the land every growing month of the year. And don't forget that nothing can surpass inoculated legumes companioned with deep-foraging weeds.

Harvesting crops from poor land that is under specific treatment is as a general rule not advisable. Neither should such land be pastured until it is well on its way toward normal productivity. Best to put everything back into the land until normal fertility is restored.

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by Joseph A. Cocannouer

14. Nature's Togetherness Law

ONE fundamental law governs inexorably every phase of organic life: Nature's law of the togetherness of things. This law of togetherness is as vital in practical agriculture as it is in the profoundest nature manipulation in which the human can play no part: for instance, in the manufacture of food in the leaf factory. This food factory is still beyond man's best ingenuity. Oh, man can help Nature in sundry ways by improving the environmental conditions of the plant; but he can take no part in the technical process of photosynthesis. Let there be the slightest interference with just one of the factors involved in the manufacturing of food, and the work of the leaf factory is slowed down; it may stop entirely.

That is why the law in operation there is the *togetherness law*. No matter where this law may be operating, there is certain to be a group of factors operating together. Often the number of these factors is close to legion, yet no matter how many there are, all must work together harmoniously. That is the heart of the law -- harmony. And that is why an understanding of the law in any specific case generally makes it possible to substitute *constructive harmony* where before there was baffling discord.

Though we may not be conscious of it or even wish to admit it, our success or failure depends very largely upon the understanding we have of Nature's law of togetherness, and our adherence to it. Every phase of agriculture is dependent upon the workings of this law. It is well enough to talk about the mechanization of crop production, but unless the machine is made to work in harmony with the togetherness law there will be trouble. The agricultural machine can be made to work with Nature instead of against her -- even those colossal machines employed in "building a farm in a day." It is not the machine that is at fault where this cooperation does not exist; it is the manipulator of the machine.

An ideal soil world, with all the factors functioning healthily and efficiently, is the togetherness law in superb manifestation. In such a soil there is supreme harmony: the necessary mineral elements are there, and the necessary gases. There is the

indispensable fiber to regulate structure and to provide food and warmth for the live factors. These factors, along with a host of others all working together, furnish and prepare the ingredients that are to be sent up to the food factory of the leaf, where they will receive the final processing. Again, let anything interfere with the soil-world laboratory -- interfere with the togetherness law down there -- and discord becomes evident in many directions: the soil itself is thrown out of balance; the leaf factory may be forced to turn off an unbalanced food product. Animal life, which is at the mercy of the plant world, finds itself responding with weakened body structures. The animal world gets sick -- and all because something interfered with the togetherness law in the soil world.

A few farmers or even a few nations ignoring this law of togetherness in maintaining soil fertility and in the production of food, will not upset the harmony of the world as a whole; but when the agriculture of the entire world is disturbed at the same time in this manner, you have a very different situation. And that is exactly where we are now. In America, in our frenzied efforts to take advantage of high prices for agricultural products, we are mining our soils instead of farming them. In the manipulation of our soils, save for a case here and there, little thought is given to the law of return compensation. In many European countries, before the late war, there were many farmers in every country who methodically recognized and practiced the law of return compensation. Since the war, however, few of them have resumed their constructive routine, being forced in many parts to soil stimulation in order to provide a quick supply of food. Japan and China, ancient models of some types of Nature farming, are also out of gear, either because of the inevitable aftermath of war, or because of the continuous effects of war.

It is a little difficult to get some American farmers to understand why or how the togetherness law of Nature can possibly mean anything in the business of farming. This is due largely to the fact that America is and always has been machine minded; always has been an industrial nation. *That includes her farmers*. Our colonial forefathers, with few exceptions, were industrialists. There were a few dirt farmers on the Mayflower and on subsequent ships, but as a rule the colonial settlers came from the small urban districts. They had been shopkeepers, small-business folk, preachers, teachers, lawyers.

In the New World for a lengthy period there was little place for the shop as it had been known in Europe; not much place for even small business. Preachers and lawyers and teachers there were who were engaged in their professions, but even they had to turn to the soil for much of their living,

And they looked upon their soil as little more than mechanical food factories. Machines of most kinds were primitive in those days, of course, but the machine mindedness was much like ours of today. Cultivated land must be as clean as a shop counter.

The Indians in a large measure were the agriculture teachers of our colonial parents. And the Red Man was a pretty keen agriculturist. The colonists declined to accept all of his "crude" wisdom, however.

It is true that the Indian's Nature wisdom was mixed with superstition, but even so his agriculture was sound. It was sound because he listened to the subtle voices of the earth. Our forefathers acknowledued their God as the giver of gifts, but saw those gifts only in the abundant harvests. The Indian gave thanks to his Great Spirit for the land that gave him his corn; the white man gave thanks for his corn. The one was a naturalist, the other an industrialist. And across the decades from that day until this our farmers have ever had their eyes on the corn, not on the soil that is responsible for the corn.

Jim Lucas, an old college friend of mine, is a good example of industrial America. Jim has always had a machine mind. Never has he been able to see how this natural togetherness I talk about can have any connection with the efficient operation of farm machinery -- or in the production of livestock and grain. It was many years after we had both left college before we met again -- and those years hadn't changed Jim Lucas a bit.

"But, Joe -- you still don't seem able to see that now more than ever we're living in a *mechanical* age!" he chided me impatiently. "There is no longer any place for your small, half-neglected farm -- or your Nature business either! Large acreage with special machines to do the farm work -- that will be our agriculture of tomorrow. Two men doing the work that now requires twenty -- "

"Wait a minute, Jim! " I stopped him. "Are you still trying to tell me you can't understand how our very existence is dependent on some very definite laws of Nature -- "

"You and your Nature stuff ! That's all very well in theory, Joe -- I'm giving you cold-blooded facts! Starving people are looking to America for food. We've got to feed 'em. We've got to mechanize our agriculture on a large scale; make our land produce to its limit -- '

No; the Jim Lucases don't see or don't wish to see how the togetherness law functions in the most rudimentary agricultural operations, as well as in the most complex. The fact is that all of us unconsciously, through trial and error, if we have been growing things in dirt, are constantly discovering bits of the law. We learn that we must *do* certain things and *not* do certain things if we expect to harvest a crop of beans or potatoes -- or a crop of desirable pigs. We accept that much of the togetherness law without questioning it. But most of us are inclined to stop short. We aren't willing to admit that we can produce more and better beans and potatoes and pigs if we will learn and practice more of the togetherness law. We aren't willing to learn how we can improve our production in both quality and quantity, and improve our land at the

same time, simply by following the mandates of the togetherness law. We aren't willing to admit that the law enters very directly into land preparation, natural soil fertilization, and into every phase of crop treatment from the planting of the seed until the harvest.

Not long ago I came face. to face with a proposition where a very considerable knowledge of the togetherness law would be needed. I was examining a small area of abandoned land, to see if it could be brought back to production again economically. Superficially, at first glance, the land looked as if it never could be other than abandoned land, no matter what one might do to it. It was not merely sick; that land appeared to be completely dead. It was just a stretch of barren, gullied and cracked subsoil that had been uncovered by erosion. It was situated on a fairly steep slope, too, with a large number of pretty deep gullies.

Before I was half through with my exploring, I found signs aplenty that the land was far from dead. It was sick, but not too sick to be cured, and that only by giving the togetherness law a bit of the right kind of assistance. How did I know that? Simply by what the togetherness law had already done and what it was fighting desperately to do.

Even the worst of weed haters would have been forced to pay the despicable weed a measure of respect had he walked with me around the edge of that abandoned field. He would have been forced to see how hardy weeds were slowly eating their way into that stiff clay -- and completely transforming the soil as they went. The weeds were inching their way forward very slowly, but they were going forward and not fighting an unproductive battle. The present process of rebuilding was entirely too slow, of course; but the law was at work constructively and needed only man's help to bring about satisfactory accomplishment in a reasonable period of time.

After I had finished my survey, I went to an oak tree that stood a short distance from the eroded field, sat down in the shade, and imagined I had the weed hater there beside me as the owner of that land; or of any other similar piece of land in the country. There he could see how to bring that piece of land back to life simply by cooperating with Nature's togetherness law. And it wouldn't take a half century to do the job, either.

It would be helpful to call in a piece or two of build-a-farm-in-a-day machinery, to get rid of those gullies in short nonce. But that wouldn't be possible. But we could brush the large gullies; build brush dams in them. There was an abundance of brush not far from the field and growing so thick that a large portion of it could be removed without starting erosion there. Cutting and hauling the brush would be an off-season job; a winter task. Then there would have to be a few terraces of a sort where the land was steep. Nothing extensive; just a few strong ridges to help hold the soil until the fiber should be put back into it. There should always be the minimum of soil stirring on a slope like that; and all plowing, of course, should be done contour. Every move must be directed toward getting a cover back onto the land. Those weeds that were

eating into the edges must be helped to spread over the entire surface. Simply gathering and scattering the weed seed wouldn't be sufficient. The land would have to have special treatment before the weeds would take hold. That would mean an application of well-rotted barnyard manure, or a commercial stimulant, preferably one rich in nitrogen.

But first of all we would have to apply two or three tons of ground limestone per acre, and a fair dose of rock phosphate. On this particular piece of land it would be better to start work in the fall, provided there was sufficient moisture. Otherwise the beginning work should be done in late winter or early spring. The region will naturally govern the best seasons for such soil-building operations.

And we want to gather all weed seed we can get hold of, especially seed from those weeds that are already growing around the edges of our field, no matter where the field is located. If we begin the main work in the spring, it is still better to apply the lime and phosphate in the fall, though these also can be put on in the spring if necessary. Better to put the elixir on -- if we use one -- just before we plant our domestic legumes, which are going to be grown with our controlled weeds. Yes, we want at least one hardy legume to grow with our weeds, and that legume inoculated, of course; to provide some quick nitrogen. It doesn't make much difference when the weed seeds are planted, so long as they are there to start early spring growth. And remember that most weeds object to having the seed covered. Just scatter the seed over the surface of the ground.

That simple procedure should help us get a good weed growth started; help us get a soil-improving cover on the land. That was what we were after in the first place. We have a right to expect the project to succeed, because we are cooperating with the togetherness law. On an extremely poor piece of eroded land we may have to make our attack two or even three times. But once one gets several clumps of vigorous weeds along with some legume patches growing on the erstwhile dead slope, one can figure the problem more than three fourths solved. The togetherness law from then on will usually carry through alone. What is ultimately done with the land will depend on the location and the farmer's desires. In any case, it should not be permitted to lose its sponge structure.

Our understanding of the togetherness law can perhaps never be complete, but, fortunately, for reasonable success in agriculture our knowledge of the law need not be extensive. For instance, we can well leave to the expert the intricacies of animal breeding, but after the specialists have given us the new breeds of livestock, it is up to us to master the togetherness factors involved in propagating the new breeds and maintaining their high standards.. The same holds equally true with plants. Individual farmers don't need to go into the intricate details required to develop a new strain of wheat; but every wheat farmer should know how to grow and maintain the purity of the grain. The only difference is that the "breeder" in every case will need to have a deeper understanding of the law.

I doubt if any man of modern times -- or any other times -- ever had as clear an understanding of the law as had Luther Burbank, especially in the plant world. Burbank recognized the togetherness law and developed his marvelous creations by adhering strictly to it. Those seemingly impossible marvels that Burbank brought forth! As one of Burbank's several cooperators -- one of those fortunate people who were given the privilege of testing the new strains under varied conditions -- I always received a specimen or two or three of many of the new plants as soon as they were released: enormous Shasta Daisies; blackberries as white as snow and seedless, which would *really* melt in your mouth. I recall one particular plant whose leaves were fifty times as sweet (according to Burbank himself) as the most concentrated sugar. The father of these wonders was not Luther Burbank the "plant wizard," as he was commonly called, but Burbank the penetrating scientist and naturalist, who was able to prove that marvels could be brought about merely by understanding and practicing the law of "Nature Harmony," the togetherness law.

One of Luther Burbank's soundest convictions never appeared in print during his lifetime: that all agriculture learning should start with a clear-cut study of Nature as the basis of all agriculture. In other words, start with a thorough study of the togetherness law. Schools of agriculture would have scoffed at the idea then, as they would today. But Luther Burbank knew his practical agriculture, as he knew his Nature. He knew the relationship that must exist between the plant and the soil for success in crop production.

My claim for weed values rests entirely upon this basic law of the togetherness of things in Nature. It would be contrary to Nature's law of harmony, for instance, not to have any means of bringing back to the surface the food materials that constantly trickle into the lower soil regions. It is true that capillary water lifts much of this material back to the surface, but soil conditions must be right before capillarity can take place efficiently. Deep-foraging weeds will fiberize the lower soils and thus help capillarity. And weeds are not robbers, save in some instances where they are uncontrolled. Instead, they are Nature's most important means of preventing waste!

The fact that many common annual weeds can be put to work constructively does not by any means indicate they are constructively valuable in all situations. Such a claim would be ridiculous. But it is even more ridiculous to insist that all wild plants are injurious when growing with domestic crops -- simply because they are "weeds." A study of the togetherness law should convince any farmer -- or anyone else who is not too poisoned with bias -- just where and how the so-called weed can be useful in carrying out the law. To help him do that, I have written this book. Blind antipathy toward weeds will get us nowhere. But a sane study of the weed as a part of the law involved in the maintenance of soil fertility can be revealing to any open-minded person.

THE END

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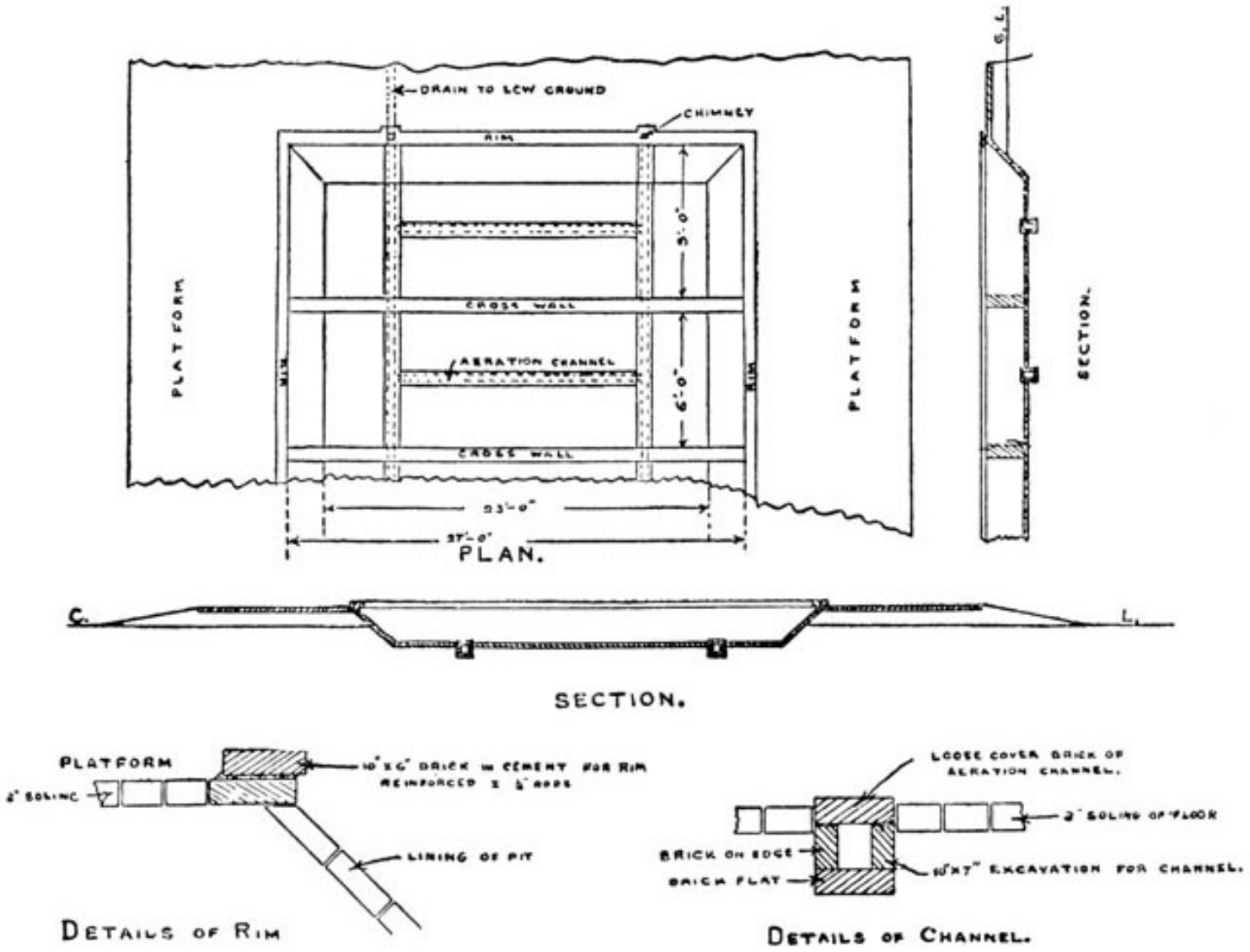

FIG. 8. Plan and working details of composting pits at Tollygunge, Calcutta.

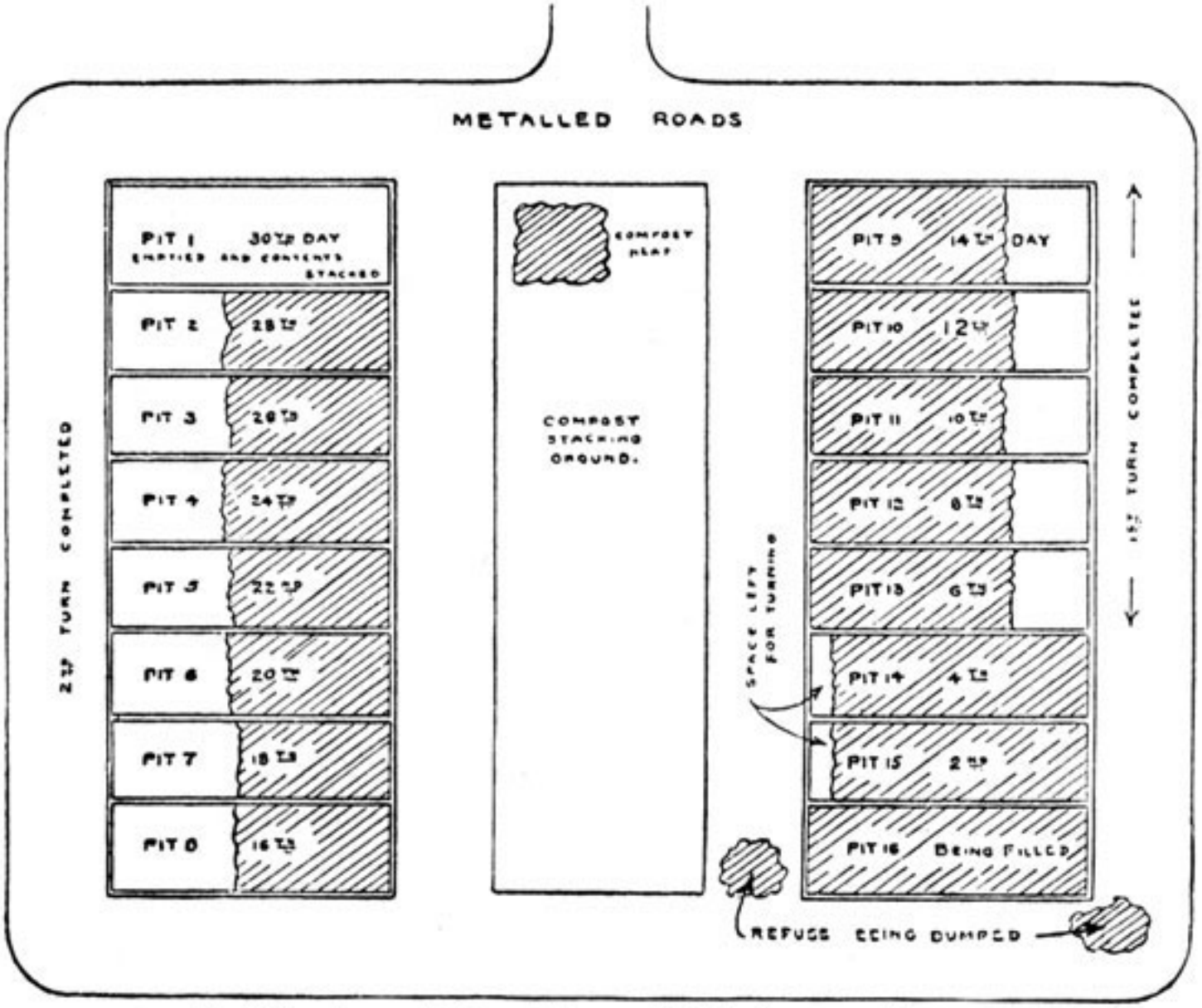

FIG. 10. Plan of compost factory at Tollygunge, Calcutta, after one month's use.

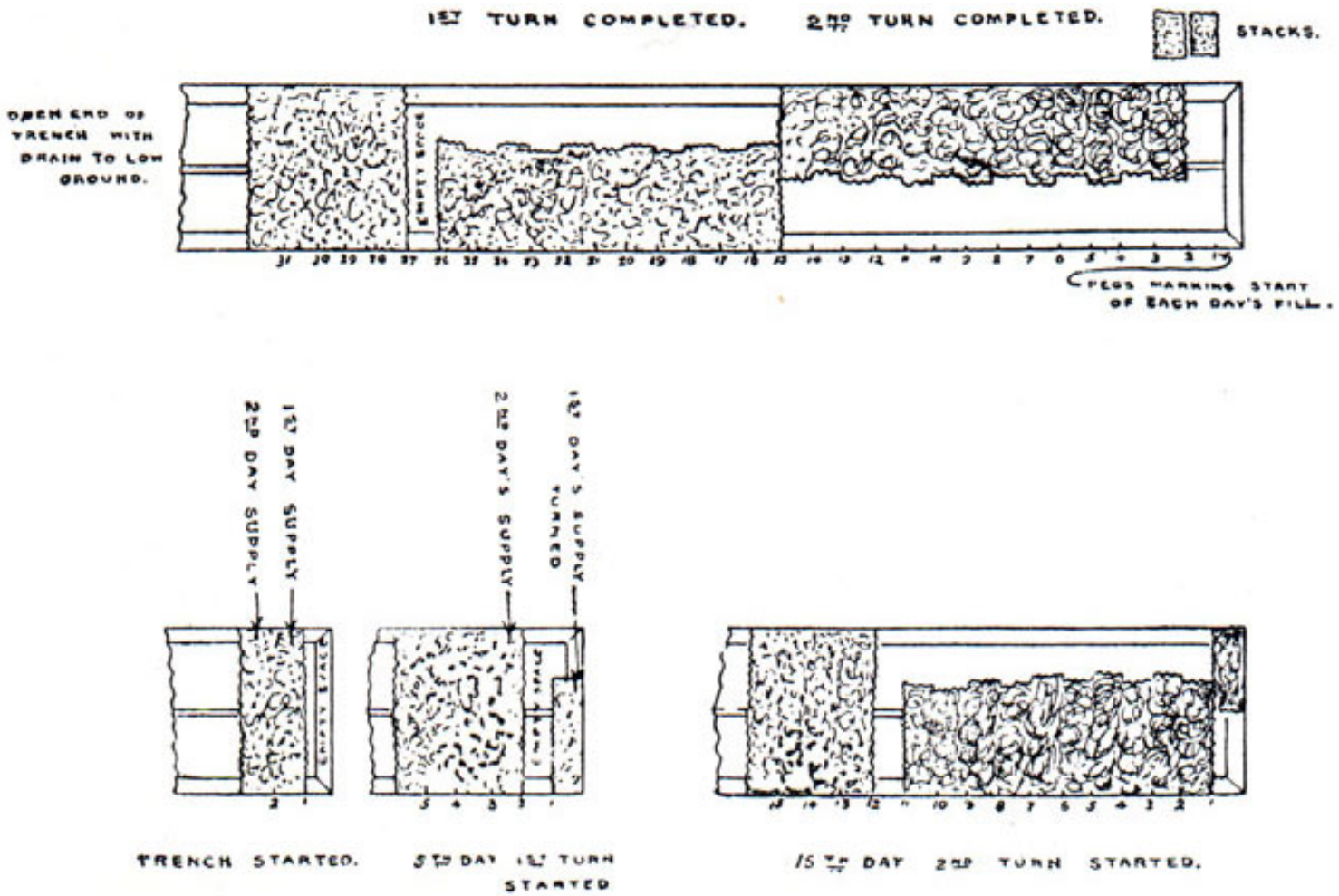

FIG. 11. Plan of a simple composting trench for a village. First and second day's produce stacked and Section 2 ready for filling.

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An Agricultural Testament

by

Sir Albert Howard, C.I.E., M.A.

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Indore, and Agricultural Adviser to States
in Central India and Rajputana

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To Gabrielle
Who is no more

The Earth, that's Nature's Mother, is her tomb;
What is her burying grave, that is her womb.
Romeo and Juliet.

And Nature, the old nurse, took
The child upon her knee,
Saying: 'Here is a story-book
Thy Father has written for thee.'

'Come, wander with me,' she said,
'Into regions yet untrod;
And read what is still unread
In the manuscripts of God.'

Longfellow
The Fiftieth Birthday of Agassiz.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 3

The Roman Foods

In the previous chapter, we have not proved the point that it was the intensive personal agriculture in a favourable soil and climate, which gave to the early Romans their physiological vigour and virile character. We have not proved it for it is not susceptible of proof as a separate entity. It can only be brought forward as an example of the reasonable supposition that the quality of the food and the animal that eats it must be interwoven. All, therefore, that we have been able to do has been to bring forward certain facts bearing upon early Latium which to some readers will at least link up with the tradition of the exceptional character of its inhabitants.

Let us now review, as far as we are able, the foods themselves from which this physiology derived.

At the beginning we are forced to realize that in history generally it is difficult to find out about the quality and character of the food of a people, and to this the early Romans afford no exception. Dr. K. Hintze, however, has in his invaluable *Geographie und Geschichte der Ernährung* collected such knowledge as persistent scholarship can reveal.

What Hintze is able to tell us about the foods of the early Romans is not copious, but nevertheless it is fully in accordance with that of some of the most virile people at present upon the earth. It has already been shown what care was given to its cultivation. That is of primary importance. One may presume that with such skilled and laborious cultivation, the soil, itself of excellent natural gifts, rendered healthy and well-growing vegetable and animal food.

There is no contemporary information, says Hintze, about the foods of early Latium; there are only the traditions, supported by the influences of modern research, of what it had been.

Of grains, there was barley, wheat (emmer) and millet. There were no mills, but the grains were crushed in a mortar and the husk removed. The grain was then made into a porridge and eaten with salt. The grains were often lightly roasted so as to make the removal of the husk easier. Later came the hand mill and the grain was crushed between two millstones.

The student of nutrition and dietetics will at once note that only the husk was removed. The porridge was thus wholemeal porridge and, if flat cakes of bread were made, they too were wholemeal.

This traditional porridge, Hintze surmises, was the staple food of the early Romans, who ate alike as there was little or no food distinction of the classes at that time.

Then came vegetables and fruit. There were cattle, but flesh was seldom eaten, except on the days of religious festivals. The animals were kept for work upon the farm, for the provision of manure, and for milk and cheese. Milk and cheese were an important part of the food.

The grape was cultivated in Italy in pre-Roman times, but in ancient Latium it seems to have been unknown. Its culture, however, reached Latium at some early date and the inhabitants then drank wine. Whether they drank wine made from other juices, as was the later habit of the Romans, is not known. Barley beer, the drink of northern peoples, never found favour in the land of the grape.

The food of the early Latin farmers was, therefore, the lacto-vegetarian, which has won such high praise from Sir Robert McCarrison and other distinguished modern nutritionists, as the food of many of the healthiest and strongest peoples of the present day. If a healthy soil can be granted to these people, then they had in their food all the necessary elements of physiological excellence.

The lacto-vegetarian diet is not the only healthy whole diet. There are other such diets, that of the Polar Eskimos for example in which whole carcass feeding plays almost but not quite as prominent a part as it does in that of the beasts of prey. But the lacto-vegetarian diet of wholemeal grains, fruits, vegetables, milk and its products, as McCarrison has shown, is the basis of the excellent health and physique of the Hunza, the Pathans and the Sikhs of North-western India and, with a more precarious supply of grain and vegetables, of the Arabs and Baggaras.

What proportion milk and its products added to the vegetables and fruit foods of the early Romans is not of course known. Their value was, one would think, firmly established in the tradition of people, some of whose ancestors came from central and eastern central Europe. It was certainly a tradition handed down to and maintained from the early days of the republic. The *latifundia* or large estates of the later republic largely specialized in milk and milk products, as well as wines and olives, and left the

growing of corn in large degree to the provinces. They raised cows, sheep, goats, horses and asses, and the milk and cheeses of the milks of all these animals were consumed with the inner knowledge, which Cossinius, in Varro's work, displays. Cossinius discusses the qualities and differences of these products as connoisseurs discuss those of wine. Nothing perhaps shows more vividly the immense gap that exists between the sophisticated town diets of to-day and that of early and middle republican Rome than this serious devotion to milk and its products.

It is in this lacto-vegetarian character that the early Roman diet allies itself, as has been said, to that of many of the finest people of the present day. It is in their intensive cultivation of the land as individual farmer-families that they resembled the Chinese, Koreans and pre-modern Japanese. It is in their traditional reverence for the nutritional qualities of milk and its products, however, that they differ from these far-eastern peoples, whose land supports so numerous a population that there is not sufficient for the support of a large number of domesticated animals as well. It is in the combination of the two, intensive cultivation and the culture of dairy products, that the Roman diet most resembled that of the Hunza people of the western Himalayas who are probably unsurpassed in physique and health by any other people of the present times. Moreover, whether by tradition or not cannot be said, but certainly in mid- and later republican times, and therefore possibly in the early Roman period, a great quantity of different fruits were cultivated in Italy, so that Hintze, at one passage, yielding perhaps to hyperbole, declares, that 'at Varro's time all Italy resembled a fruit garden'. In this generous provision of fruit, the diet resembled that of the present-day Hunza, who eat great quantities of fresh and sun-dried fruits. It also has allied to it the great quantities of dates, which those other people of superb physique, the Arabs of Arabia, eat.

As regards early Roman agriculture, the intensity of which has already been indicated, Frank praises its practical efficiency. Professor Whitney, in his great work *Soil and Civilization* (1926), writes of the Roman knowledge of certain principles and practices, such as their recognition of the different types of soil and the crops suitable for them; their recognition of the need of local knowledge of the soil and its preservation by successive generations of families cultivating the soil, where they themselves were born and bred; their use of legumes which allied them to the prolonged agricultural history of the Chinese, as also in their avoidance of any waste upon the farm, all animal and vegetable refuse being returned to the soil as manure, and other technical features of agricultural practice upon which a competent student of practical agriculture like Whitney is qualified to write and to whose book I refer the interested reader.

There is therefore, I think, quite sufficient evidence to presume that the Romans and their neighbours belonged to those people who by long adaptation to a repetitive, well-cultivated, sound diet, seem to have acquired an absolute harmony with their food, and, as a sequential necessity, were themselves a people of exceptional physique and health. The foundations of their western world dominion included their

foods and agriculture.

The change in both came with the spread of that dominion.

The change amongst the agricultural Italians was much slower in its ingress than it was amongst the rapidly increasing urban populations. The rural people were necessarily affected by the changes recorded in the previous chapter, but their foods were still locally produced, milk and its products, grains, vegetables, fruit, oil, wine and occasional meat.

It was upon the metropolis and other major urban centres that the chief effect of the change fell. The bread or porridge of the lower classes was now prepared, not from local grains, but from grain imported across the seas from Egypt and northern Africa. 'The sustenance of the Roman people is day by day being tossed about at the caprice of wave and storm', were the words of the Emperor Tiberius to the Senate. But that is almost all that can be said with accuracy about the urban lower classes and their food. Hintze laments that 'unfortunately as concerns the life of the smaller folk, comprising the mass of the population, we can learn practically nothing from the writers of the time'.

It is a very different story as regards the wealthier classes of the later republican and early imperial Rome. Their breakaway from the simplicity of their great ancestors to luxury were frequent themes of the writers of the time. The wealthy Romans were indulgent of their appetites. Taste and the temptations of delicate dishes replaced the satisfaction of robust appetites. Dinner (cena), beginning about 3 p.m., became a cult. Individually and socially it occupied by its time alone, which was three or more hours, a considerable part of the day.

Hintze gives a list of the foods in their variety which reached the table at the time of the empire: milk, cheese, honey, wine, wheat, barley, millet, beans, lentils, peas, cabbage and other leafy vegetables, tubers, beets, turnips, radish, salad, onion, cucumber, celery, mushrooms, truffles, dill, mint, garlic, coriander, mustard, pepper, cardamon, olives, grapes, apples, oranges, lemons, dates, pears, plums, cherries, figs, quinces, apricots, peaches, almonds, walnuts, hazelnuts, fruit-wines of apple, pear, pomegranate, mulberry and other juices, mutton, goat, pig, deer, boar, chamois, antelope, hare, spiced meats, smoked meats, hams, goose, chicken, ortolan, bunting, starling, thrush, dove, peacock, flamingo, guineafowl, fish, mussels, crabs, lobsters and oysters. Beef was not much eaten, the bullock being kept for labour and the cow for milk.

There was, therefore, a complete change from the ancestral lacto-vegetarian diet to one drawn from all parts of the available world by the fame and wealth of Rome.

The new diet had what has been termed the virtue of variety. Whether the incentive of variety or the adaptation of familiarity is better for individual men cannot be answered. As far as I know, the question is one of those which has had little attention

paid to it.

One can only repeat facts. This very varied diet is essentially one of wealthy urban or urbanized classes, and it entails gradations downwards to the masses of the urban population. Immediately below the upper class which gets the pick of the food, there is a grade which gets the foods that are in excess of those required by the rich or those slightly spoilt for the fastidious palates of the wealthy. So the diet passes downwards, contracts, and changes to that of the lower classes, who, in the case of Rome, depended for their staple food on distant countries.

It is most important, however, here to realize that the defects due to poor food are acquired defects and therefore they are not, in the commonly accepted view of modern science, inheritable or inherited defects. Any poor Roman, who by wisdom or fortune, received a good diet from conception onwards, would show the better physique and health which that diet ensured. As to the rich, their varied diet judiciously used clearly gave opportunity for health and fine bodily quality, for the rich mostly had estates and other means of access to good milk, cheese, oil, fruit, vegetables and corn.

The rural population, like the wealthy, had access to fresh food. The growing of wheat in Italy did not come to an end. 'In Nero's day,' writes Frank, 'Egypt sent about five million bushels of wheat to Rome annually while Africa sent about twice as much. That would suffice for the capital alone, and reveals why cereal-culture could be neglected in the vicinity of the city. But the rest of Italy had a population of about fifteen millions and they would require more than 150 million bushels a year ... We must conclude therefore that wheat was very extensively and successfully raised during the first century.'

The foods of Rome of the period of dominion may then be summed up broadly as four.

Firstly, there were the small farm home-produced foods to the Italian countrymen. These approached most closely of the four groups to the traditional foods of their ancestry. To what degree they did so it is impossible to relate, for as Mr. H. Stuart Jones says in *Companion to Roman History*, 1912, though 'there is good evidence in the literature and inscriptions of the early Empire that the small holding was far from extinct in A.D. 100 and later, we know so little of its working that we can only describe the *fundus* of the capitalistic landowner as Cato and Varro picture it.'

Secondly, there were the home-produced foods of the slave-worked *latifundia*. Under the late republic the condition of the slaves was wretched in the extreme. Under the empire their lot was gradually ameliorated. Their foods were presumably not the equal of the first group. Moreover, the specialization of the estate limited the number of foods compared to that produced on the general farm.

Thirdly, there was the varied diet of the wealthy classes comprised of fresh foods from their own or neighbouring farms and estates, fish from the seas and rivers, and luxury foods imported from abroad.

Lastly, there was the food of the lower urban classes. Of this Mr. F. H. Marshall, in Sir John Sandys' *A Companion to Latin Studies*, 1921, writes: a kind of porridge of wheat, like that eaten in early republican times 'even in imperial times continued to be eaten by the classes ... with green vegetables, seldom meat'. The grain was still consumed as a wholemeal grain. As to its quality, there is no means of comparing it with the wheat or emmer and other grains of early Latium. But its wholemeal character was certainly preserved.

This is about the only fact of importance one can gather from what is known of the food of the urban lower classes. One knows little or nothing about their access to dairy foods. As already quoted, Hintze states that 'unfortunately as concerns the life of the smaller folk, comprising the mass of the population, we can learn practically nothing from the writers of the time'.

Summing up one may assert that compared to the foods produced by the farmers of early Latium, that of the first group approached, but owing to the increasing difficulties of the farmers, cannot have reached that of the early period.

The food of the second class of the agricultural slaves was certainly inferior.

The food of the third class, the wealthy, is less comparable. It is not possible to state, but it is possible to imagine that it produced a greater variety of human qualities. That it also brought with it the deterioration of over-luxurious and over-gross feeding is certain. Nevertheless, the daily life of its eaters, their gymnastics, games, and bathing proves the persistence of the ideal of bodily health and physique.

The food of the fourth class, the poorer urban class, was certainly inferior.

With the degeneration of Italian agriculture, there came a degeneration of foods and their quality, and a degeneration of the eaters of these foods. To whatever other causes the decline and fall of the Western Empire was due, this of its foods was assuredly amongst the primary ones. It suggests that no empire can endure with its centre in the motherland, if the agriculture of the motherland deteriorates. The process is naturally a slow one and as such was not mentally impressed upon the Romans as a people, though realized by many of its thoughtful and prominent men.

Chapter 4

The Roman Family

The human group, by which the farming of early Latium was carried out, was the family. A slave of that time was one of the family and took his part in the general work and domestic life without degradation.

The human family and the cultivated soil were indissolubly connected; the family was pledged and wedded to the soil. The very type of marriage, that of monogamy, was dictated by the soil.

The farm provided the family group with food, clothing, shelter, fuel and an overflow of produce for exchange for goods produced by others. It gave security to the children and old people, and the security was continuous so long as the soil was well-husbanded. The peculiar knowledge of the family and of their ancestry was that of their farm and all that affected it.

To the family its land with its particularities was as living and particular as were their own particularities. The creation of children to continue the family was, as it were, an aspect or relation of the creative quality of the soil. The blended intimacy was an intimacy formed within the mystery of the recurrent creation of both. The farming family was inevitably religious; it was so near in its life to the abundant life in which it was itself the agent of creation; in death it was so near to the inevitability of the resurrection of that which is apparently dead but which, mixed with the soil, again joins the regions of life.

Every schoolboy, recalling his Roman history, carries in his mind the grim figure of the *pater familias*, the head of a Roman family, who preserved the form of the family and punished any member of it who endangered its corporative existence, and did not in extreme cases hesitate to inflict death upon his own flesh and blood.

Ordinarily, one may presume, as member of a family he was not grim, but the fact that he had those traditional powers showed that the family was cultivated with as great an intensity as the land; and his summoning of the family at the awakening of day to the worship of the household gods showed that that, which man ultimately does not reach but which by intimacy he can approach, was a deeper interpretation of the common life upon the farm.

The family was the large or joint family, which is the form of family particularly correlated with the intensive hereditary cultivation of small farms. It was the large or joint family consisting of the father and mother, their sons and grandsons with their wives and children, and their unmarried daughters. The men worked upon the land and for the State, the women worked for the family. Outside the family woman had no recognized place. She inherited her portion of the family land, but that was for her security and not to give her individual scope for agricultural skill or toil.

She was the mother and the housewife. But in the relation of her children to the State and family, she was subordinate to the *pater familias*. It was he who had an absolute legal right to decide whether a child born to him or in his family should be reared or not. It was he who ordained the death of a defective child or one threatening the family unit by over-population. 'The maxim was not suggested by indifference to the possession of a family,' is Mommsen's comment. 'On the contrary, the conviction that the founding of a house and the begetting of children were a moral necessity and a public duty had a deep and earnest hold of the Roman mind.'

But the family had to be strong in its individual units and in itself as a unit of the State. It had to be strong because the proper service of the soil demanded physiological strength, and the strong State, the State that could successfully defend itself against invaders and aggressive neighbours, had to be compounded of strong family units. The family was, indeed, the very essence of the State. 'Of all Roman institutions marriage was the most sacred,' wrote Mr. Romaine Patterson in *The Nemesis of Nations*, 1907. 'The family altar, transmitted from one generation to another and holding a fire which had been lit by ancestors who had been dead for centuries, was the central and most impressive fact in the life of a Roman burgess.'

The economy which was attached to this sanctity of the family has been called a 'natural economy'. After the Punic Wars, there arose as its rival and supplementer a 'money economy'. The new rich, in the main, were new men, the Equites. The older landed aristocracy, as was to be seen later in other nations, were not a match for the new men. It was the Equites who made and controlled the money economy in its various forms. *They* farmed rents, taxes, customs, excise and other duties. They controlled the import of food, the slave trade, and the creation and circulation of money. The most certain path to wealth was the profession of banking. Only exceptional cleverness or luck in speculation built up wealth more rapidly than did banking, and this very speculation was supported by the bankers. Almost all, who laid claim to credit, fell into the bankers' debt. The successful politicians depended upon the backing given to them by the bankers. Capital, labour and competition, under the money economy, became commonplaces, though unknown under natural economy. In the growing ascendancy of money economy, the bankers necessarily became indispensable, and eventually the whole State became an exhibition of their indispensability. Everything hung from them as the staples of the State. Property concentrated. The tribune, Philippas, quoted by Cicero, stated that there were only 2,000 property and landowners in the whole Commonwealth.

The effect upon the family and marriage was profound; they both began to lose their meaning, and indeed did lose the greater part of their meaning. As the sacredness of marriage and the family fell, it is in the women of the upper class -- the class which, as in the case of food, practically monopolized the pens of the great Roman writers from which we get our information -- that the change of values is most vividly illustrated.

The Roman matrons now became figures of tradition. The object of the fashionable ladies was the *reverse* of that of the displaced *domina* or mistress of the home and family. Their desire was to avoid by all possible means the appearance of being matronly. To conceal all appearances of advancing years, to look young, attractive and ripe for adventure, that was, in particular the object of the society women. Their culture was beauty culture, their scarcely concealed convention was to occupy themselves with love affairs without fruition. As, perhaps, a form of revenge for the secret desolation of their wifehood and motherhood, they wasted the imperial resources with lavish prodigality. Fashion and beauty cost so much that thousands of slaves throughout the empire were necessary to support them. The passion for personal freedom, in the sense of untrammelled desire, divided them from the few children which they had. The younger folk, on their part, freed themselves from the shackles of parental authority. The *pater familias* vanished into the past with the *domina*. The family elders, once honoured as the store-house of experience and wisdom and links with the past, were unreverenced and made to feel the uselessness of old age.

I cannot better substantiate the accuracy of the picture of the upper class Roman women than quote Theodor Mommsen's account in his *History of Rome*. He is describing the time when society had first erected itself to a great height of luxury upon the wealth that accrued from the exploitation of Rome's widespread provinces and the great number of slaves, which filled the place in the Roman world that machines were to fill in the Industrial Era. Amongst society, he wrote: 'Morality and family life were treated as antiquated things amongst the ranks of society. To be poor was not merely the saddest disgrace and the worst crime, but the only disgrace and the only crime.' The effect upon society women, he described in these words: 'Liaisons in the first houses had become so frequent, that only a scandal altogether exceptional could make them the subject of special talk; a judicial interference seemed now almost ridiculous. An unparalleled scandal, such as Publius Clodius produced in 61 B.C. at the women's festival in the house of the Pontifex Maximus, although a thousand times worse than the occurrences which fifty years before had led to a series of capital sentences, passed almost without investigation and wholly without punishment. The watering-place season -- in April, when business was suspended and the world of quality congregated in Baiae and Puteoli -- derived its chief charm from the relations licit and illicit which, along with music and song and elegant breakfasts on board or on shore, enlivened the gondola voyages. There the ladies held absolute sway; but they were by no means content with this domain which rightfully belonged to them; but also acted as politicians, appeared in party conferences and took part with their money and their intrigues in the wild coterie-proceedings of the time.' 'Celibacy and childlessness became common, especially amongst the upper classes,' and it was held to be the duty of 'a citizen to keep great wealth together and therefore not to beget too many children'.

Childlessness, indeed, had further advantages. Men and women who had children were debarred from the joys of society and were omitted from invitations to social

gatherings. Hence Seneca (5 B.C. - A.D. 65), himself a man of great wealth, whose strange attachment to Stoic philosophy led him, with his colleague Burrus, to the wise and humane government of the first five years of Nero's reign, did not think it ill, in a manner that would have outraged the farmer-Romans, to console a mother who had lost her only son by pointing out that she would now be free to enjoy the pleasures and prestige of society.

Nothing could better than this convey the gulf that formed between the position of the women of 'natural economy' and the dominant women of 'money economy'. But it is juster to regard this great change as an example of relativity than to condemn it on the grounds of morality. The conduct of the first women was relative to the pre-eminence of the soil, that of the second to the pre-eminence of money. The first economy was preservative of life and the soil, the second was destructive. How destructive it was will be seen in the next chapter.

Chapter 5

Roman Soil Erosion

The best summary of this aspect of Roman history which I have read is that of Professor Simkhovitch, in an essay published in the *Political Science Quarterly* of the Columbia University, 1916, under the title of 'Rome's Fall Reconsidered'.

Simkhovitch began with quotations from Roman writers, Pliny, Horace, Varro, Columella and others, who were fully aware of Rome's progressive degradation at the roots. The process was a slow, progressive exhaustion of soil fertility. It was not due to lack of knowledge of good farming, for, 'nothing could be more startling than the Roman knowledge of rational and intensive agriculture'. Nor, I think, could it be said to be due to debt, for debt did not begin its devastating career until the fertility of the soil became impoverished. Debt was not necessary as long as the farming families were able to give their time to intensive cultivation.

The spread of the degradation of the soil was centrifugal from Latium itself outwards. Varro noted abandoned fields in Latium, and two centuries later Columella, about A.D. 60, referred to all Latium as a country where the people would have died of starvation, but for their share of Rome's imported corn. The Roman armies moved outwards from Latium demanding land; victory gave more land to the farmers; excessive demands again brought exhaustion of fertility; again the armies moved outwards.

'Province after province was turned by Rome into a desert,' wrote Simkhovitch, 'for Rome's exactions naturally compelled greater exploitation of the conquered soil and its more rapid exhaustion. Province after province was conquered by Rome to feed the growing proletariat with its corn and to enrich the prosperous with its loot. The

devastation of war abroad and at home helped the process along. The only exception to the rule of spoliation and exhaustion was Egypt, because of the overflow of the Nile. For this reason Egypt played a unique role in the empire. It was the emperor's personal possession, and neither senators nor knights could visit it without special permission, for even a small force, as Tacitus stated, might "block up the plentiful corn country and reduce all Italy to submission".'

Latium, Campania, Sardinia, Sicily, Spain, Northern Africa, as Roman granaries, were successively reduced to exhaustion. Abandoned land in Latium and Campania turned into swamps, in Northern Africa into desert. The forest-clad hills were denuded. 'The decline of the Roman Empire is a story of deforestation, soil exhaustion and erosion,' wrote Mr. G. V. Jacks in *The Rape of the Earth*. 'From Spain to Palestine there are no forests left on the Mediterranean littoral, the region is pronouncedly arid instead of having the mild humid character of forest-clad land, and most of its former bounteously rich top-soil is lying at the bottom of the sea.'

The same fate at a later date fell upon Asia Minor, the decline of the Eastern repeating that of the Western Empire in its soil-aspects. Sir William Ramsay, in *The National Geographical Magazine* of November, 1922, wrote one of those articles which almost stagger one with the super-eminence of the treatment of the soil in the story of mankind. The Province of Asia 'in Roman times was highly populated and therefore highly cultivated ... It is difficult to give by statistics any conception of the great wealth and the numerous population of Asia Minor in the Roman period. In the single province of "Asia", to use the Roman name for the western part of the peninsula, which was the richest and most highly educated of the whole country, there were 230 cities which each struck its own special coinage, under its own name and its own magistrates, each proud of its individuality and character as a self-governing unit in the great Empire.'

Sir William carried out a careful exploration of some of the areas of high cultivation, which he regarded as the necessary basis of this wealthy province. What he found was what is found elsewhere, namely, hills denuded of forest and swept by heavy seasonal rains, and what he further found was the relics of the extensive terraced engineering by which the nourishing water had once been conserved and distributed: 'In older time', he wrote, 'the numerous terraces would have detained the water from point to point up the mountain side, preventing it from ever acquiring a sufficient volume to sweep down in a destroying flood.' Against this fertile land came invaders. First came the least destructive, the Arabs, least destructive because they observed in war the sanctity of trees. The Arabs could under the rules of war destroy the crops and produce of the enemy, but only exceptionally the tree, which conserved the soil. 'It was left to the Crusaders under the command of German, Norman and Frankish nobles and bishops, to inaugurate the era of total destruction of a country by cutting down the trees ... These broke the strength of an organized society by reducing a great part of the country from the agricultural to the nomadic stage. The supply of food diminished accordingly, and with the waning of the food-supply the population

necessarily decreased.

'A decreasing population', continued this masterly account, 'in its turn was unable to supply the labour necessary to maintain the old standard of water engineering, on which prosperity rested. Gradually industries languished and died in the towns as well as the agriculture in the country. The Sultans did what they could. Neither the Seljuk Turks nor the Ottoman Turks were actuated by fanaticism. They wished to preserve the old social system so far as it was consistent with the dominance of a conquering caste; but they could not maintain the education which was necessary in the old Roman system ... Thus the whole basis of prosperity was wrecked, not by intention, but by steady decay. A number of causes co-operated and each cause intensified the others. Can the prosperity of this derelict land be restored?'

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Reconstruction by Way of the Soil

by

G.T. Wrench

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This book by Dr. Wrench enters a field very different from that of his *Wheel of Life* and challenges judgment and criticism of a different kind. It is nothing less than an outline history of the relation between civilization and the soil: which means that it is not only a brief universal history of agriculture but much more besides. No work of scholarship could be devoted to a purpose more useful to mankind at any time, and at the present time none could fill a more urgent need. There is, we believe, nothing of the kind in existence; and if there were it would be out of date, since so vast a

quantity of new and important knowledge on the subject has lately become available.

Dr. Wrench has the advantage of many years' experience of agrobiological affairs in this country and in India. He gives us here a series of brief histories and striking examples of the effects of civilizations upon their primary biological resources. He first states the essential principles of sound agronomy; then he gives examples of their fulfilment or violation in China, Mesopotamia, the Roman Empire and in Islamic Spain; in England through the centuries, in Africa since the coming of the Europeans, in Egypt and India and the Dutch Empire, in the British Dominions and colonies, in the U.S.S.R. and in the U.S.A. to-day. Dr. Wrench's plea for the recognition of natural laws in the symbiosis of soil and civilization is supported by impressive evidence; and his thesis is of the first importance, not only to agronomists, but to students of politics and to all who are concerned with the future of our damaged civilization.

To
Lord Northbourne

My friend is that one whom I can associate with my choicest thought. -- Thoreau

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Acknowledgements

In the construction of this book, I am indebted to many living authors, whose words I have quoted in my text. Amongst them, I feel I owe an especial tribute and apology to Mrs. Elspeth Huxley for the use I have made of her book *The Red Strangers*, a tribute in my immeasurable admiration for her exquisite story, an apology in that, being in India, I have not been able personally to visit her to explain my enforced encroachment.

In my faith in primary value of the soil I have been greatly strengthened by the books of two honoured friends, the Earl of Portsmouth's *Alternative to Death* and Lord Northbourne's *Look to the Land*.

The Earl's book, published in 1943, has only recently reached me. With a general outlook closely similar to my own, the author has something which I do not possess, namely, an intimate, personal knowledge of all that pertains to the soil of Britain. His book constitutes the comprehensive guide for which all workers, determined to give a sane, terrene basis to our national life, have been looking.

Lord Northbourne's book was published in 1940, and it has been my frequent companion in the three years which I have taken in the actual writing of this book. Lord Northbourne has also helped me in ways surpassing the usual kindness of friendship. He has taken full charge of the typescript of the book in England, and, by

a careful study of the text, has assisted me with most acceptable criticisms.

Lastly, I desire to thank my friend, Dr. Haji Kassim, for his great help in the compilation of the twenty-first and twenty-second chapters.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 1

Introductory

It will be clear to a reader, who, like a prospector sampling a face of rock, runs his eye down the page of Contents of this book, that its subject is a general one. It is, indeed, widespread both in space and time, yet in spite of its generality it cannot be said to be widely recognized; so little so, in fact, that to not a few it will appear a new subject. Men, under the advanced differentiation of the present, are apt to think of themselves as finished products, as soldiers, merchants, sailors, engineers, lawyers and so on; to speculate on what they, one and all, actually are, seldom occupies many of them for more than a few casual brevities of time.

Nevertheless, now that they are involved in a supreme crisis, now that, however complete victory may be, the future cannot be the replica of the past, it is inconceivable that men will not be forced to face fundamental questions, such as, in previous times of habit and routine, they were able to avoid.

They have already come to learn that this age, so distinguished for its scientific progress and its widespread knowledge has, in spite of these advantages, completely failed in its promise of peace and prosperity. Even in such vital social problems as feeding and employment, it has failed and failed signally. Men, who have now been forced to experience in their own persons, and therefore to reflect upon these two problems, are astounded that their settlement has been so definitely brought about by war. Where peace failed, war succeeded. The will of the people and the skill of organization have assured all of their share in the national food, and those who do hard manual labour can reckon on sufficient energy being given to them by their allowance to accomplish their work without the weariness that results from a partial starvation in essential foods. Why, then, is war so much juster in these respects than peace? What is lacking in times of peace, that comes into being in times of war? Is it that under the supreme strain of war against a powerful and ruthless enemy there arises in the homeland a peace, goodwill, and indeed a veritable brotherhood of man,

which displaces the greedy competition, the covert hostility and the social barriers of peace that destroy the best qualities of country, blood and language? Does our civilization need war to make a decency of human conduct prevail?

Many answers have been given to these and kindred questions, but in order to look at them afresh, it is proposed in this book to review conditions, both historical and immediate, with a vision untarnished by the pride of the present, the pride attached to that in which one's ego has its being. This is a hard saying, for all are tarred with the same brush, and none can claim impartiality exempting him from his heritage and the prejudice of circumstance.

Yet, if we are to enjoy a better communal and individual life after the war than before it, the attempt has to be made with the probity it demands.

To introduce the attempt is the object of this opening chapter, and to make this beginning we will try to look at men, not as final products, not as labourers, merchants, shopmen and the rest, not as rich and poor, sick and healthy, wise and foolish, but as they are, all and each, inseparably linked together in a common likeness, which will pervade the chapters of this book. This likeness is that they are all feeding animals, getting, mostly and daily, their life from the products of the soil. Like other forms of life, vegetable and animal, men are dependent for their existence upon the crust of the globular earth on which they live.

Men, however, possess a marked peculiarity which distinguishes them from other forms of earthly life. It is this -- that they alone have been able to make themselves partners in the creative power of the soil. They alone are agriculturists or farmers, whereby they assure themselves the constancy of their food, clothing and other primal necessities in place of having to trust to the gifts of chance. They alone, amidst terrene life, have acquired a quota of mastery in creation.

In this ability to take a part in the creation of their necessities, men have gained something more than a repetitive increase of their food. They have gained an understanding, dim though it may be, of a relation between themselves and the powers which rule the universe and that minute part of it on which they live. They realize that to be partners in creation, they have to submit themselves to the unavoidable autocracy of these powers; they have to be, in their own language, creatures of the Creator, and as such, however headstrong and dominant they may be over weaker forms of life than theirs, they are, nevertheless, like them limited by the laws of their existence. Upon the basis of limitation, they are inevitably compelled to shape their individual and social lives. Should they transgress, they or their descendants are inevitably punished.

These rules and restrictions, under which mankind lives, are those of the nature of life and death. Life and death are the two essential conditions of terrene existence; they are the two different phases of this existence. The living ceases to be what is called living, but it is not lost to the cycle of existence but remains within it as a necessary

part of it. In the condition which is called dead, matter is commonly in the soil or will eventually reach it. That which, by its life, has often had the power to lift itself from the crust of the earth, now returns to that crust. There it plays an essential part in promoting further life. In a word, there is no actual death as a permanent thing. There is a suspension of life. Death itself is but a phase of life, in which the dead matter returns to the soil, where it is reformed into living matter again. *There is nothing that has once taken life from the soil, that will not, by reaching the soil, again become living.* The dead leaf, that we see lying on the path at our feet, is not dead in the sense of being finished. Let it lie, and, through the creative agency of the soil, its substance will again enter into a blade of grass, a flower, an insect, bird or animal and so return to the kingdom of the living.

Life and death are, therefore, not separate entities, but phases of each other. The living has to respect the dead as a part of itself, not finally dead but living, and this respect has been expressed in the religious mind of man by various forms of reverence in which the innate eternity of life in its most highly developed form, that of the human soul, is recognized.

When man does not interfere and the soil is left to itself, it does not fail. Through it everything that has passed from a state of life is restored again to a state of life; nothing fails or is lost. In the philosophy of modern science, however, the seeds that lie scattered upon the ground and do not fructify are stigmatized as failures, but those that grow into plants are dubbed the fittest, because they survive and expand into plants. Yet the other seeds survive no less; they re-enter cycles of life by other paths. Some even enter the very plants to which their fellow-seeds have given rise. So, for example, every one of the countless seeds of the elm that bestrew the ground in early summer, as well as the fittest surviving as elm plants, are not failures in the symphony of nature. In a musical symphony, each note, even the lowest and lowliest, *fits*. It is not a question of the fittest excluding or making superfluous the remainder. That is a wholly false outlook upon the processes of terrene life. Each has its place without which the whole is incomplete. Each has its place in a creative cycle, each passes from soil to plant and then, in many cases, to animal, and, after an interlude of death, returns to the creative realm of soil.

This is the symphony of nature and creation to which men as terrene animals are inevitably bound and yet not wholly bound. Though they themselves are products of the soil, yet through the possession of their intellect, they have become co-creators and, in their limited human sphere, fashioned in the image of the Creator. They can produce life other than their own. To do this in accord with the processes of creation, they must themselves be continuous and limited in production; they must act in harmony with the process as it exists on earth apart from them. Here they have to *fit*. They have to act within a process of balance. In it the living as a whole is balanced by the dead as a whole. In the living itself, its chief forms, vegetable and animal, balance each other. They are interdependent, and are incomplete without each other. In the exchange of vegetable and animal life with the enveloping atmosphere, a similar

balance is effected. It has to be regarded as a whole of balanced parts and therefore partakes, in human phraseology, of the character of art. Nothing in it is isolated, everything belongs to the pattern. From this art of fitting within the whole, certain consequences necessarily follow. Wholeness or health -- two words of a like origin and meaning -- is one consequence.

This wholeness as a consequence has to be proved. Though it seems logical enough, yet little has been done to prove it in an age of unprecedented speed and discovery, of immense progress at a constantly expanding periphery, which by distance has almost shut men's ultimate terrenity from their vision.

We are to-day no longer whole or healthy physically or mentally. In the careful work of the Peckham investigators it has been established that the vast majority of us are subnormal. We seem to have broken away from the great primary fact of our existence, namely, that we are first and foremost *terrene animals*, and, until we regain that fact and put it into practice, we cannot expect our social and individual lives to be whole. Our civilization, threatened with destruction as we know it to be, has to be *healed* -- another word meaning whole -- and to be healed it has to be overhauled and *reconstructed in its relation to the soil that provides it with the means of existence*.

This was the task that in dim outline presented itself to the author when, as a medical student, he was appalled by the crowded gatherings of the out-patient department of a large London hospital. 'Why disease? What then is health?' were the questions that often vexed him. To answer them he had not the opportunity, nor the tenacity which truly great men have in pursuing an object that is to them a consuming passion and for which they will forgo the pleasures of life, and end -- God knows how often -- in destitution and despair. For that heroic life he had not courage, but the questions did not entirely leave him, and it was when he had leisure in which to retire for a space of years, brought to an end by the war, that he was able to gather material for the answer to this *first question of correct terrene being*: 'Is there a relation of man to the soil which assures his health?'

The answer came as a decided yes, and in the instances he was able to gather, he found that a group of men could acquire health if they gave to the soil, from which they lived, all the food and water it required, and if they did not weaken it by exceeding the limits of the creative powers which nature had allotted to it.

His chief lesson he gained from a little, shut-away people called the Hunza, to whom he was attracted by what Sir Robert McCarrison, who knew them well, wrote of them: 'They are long lived, vigorous in youth and age, capable of great endurance and enjoy a remarkable freedom from disease in general.'

His further inquiries opened out a prospect of intense interest and even beauty such as their own mountain valley, amidst the vast mountains of the Karakoram in North-west India, possessed. He found that they pursued a close attention to the soil, which

strangely enough, seemingly related them to a time of the golden age of agriculture. As a strengthening of this supposition, he found that their present farming recalled to that most cultured of mountaineers, the late Lord Conway, the unsurpassed farming of pre-Spanish Peru, the remnants of which he had seen and which caused another well-cultured explorer of these gigantic relics, Mr. O. F. Cook of the Bureau of Plant Industry of the U.S.A. Department of Agriculture, to exclaim: 'Agriculture is not a lost art, but must be reckoned as one of those which reached a remarkable development in the remote past and afterwards declined.' The glowing pages of Prescott's second chapter in the *Conquest of Peru* seem to shine again amidst this little people, huddled between the highest congress of great mountains that uprises from our globe.

The author found that this people meticulously preserved the rule of return; they were, indeed, the source of the understanding of the ultimate nature of the soil and man and of the warp and woof of life and death, to which he has referred a few pages back. Nothing that once got life from the Hunzas' soil was ever wasted but all, from the least fleck of wool, the fallen leaf, the broken nutshell, to human refuse itself, was gathered and, after suitable preparation, returned to the soil for its food. He found that the Hunzas paid the same heed to water, which, by means of their principal aqueduct, the Berber -- itself famous far beyond the limit of their own small country -- they brought with its silt from a glacier snout to their terraced fields. Of the Berber, Lord Conway wrote: 'The Alps contain no *Wasserleitung* which for volume and boldness of position can be compared to the Hunza canal. It is a wonderful work for such a toolless people as the Hunzakats to have accomplished, and it must have been done many centuries ago and maintained ever since, for it is the life-blood of the valley.' Here, too, they were like the people of Peru, of whose water-ways, stretching for hundreds of miles athwart the slopes and precipices of mountains, Prescott wrote: 'That they should have accomplished these difficult works with such tools as they possessed is truly wonderful.'

The words 'many centuries ago' led the author to further inquiries. He found that Professor N. I. Vavilov, of the Institute of Applied Botany, Leningrad, had discovered that the area of which the Hunza Valley forms a part 'is one of the most important primary world agricultural centres, where the diversity of a whole series of plants have originated'. The people of ancient Peru, according to Mr. Cook, also produced a wonderful series of plants in the secluded valleys of the Andes and so made them the most important originating agricultural centre in America.

Here, then, within the precincts of British-supervised India, was a people who brought quite a marvellous message from the remote past, a past that justifies the tradition of the Golden Age, a past of perfect relations between men and the soil. The Hunzas had created a symphony of nature. As each note, however humble, has its proper place in a symphony of Beethoven, so even the humblest fallen leaf, each drop of water have their place in the symphony of Hunza. The author learnt from its example that the work of the Hunza, too, was an art in its original sense from *aro*, to 'fit'. ***He learnt that***

farming is an art and something infinitely wider than scientific agriculture. It is a way of life itself.

So much for health, such health and the constant cheerfulness of wholeness, which the Hunza now enjoy. There are many other examples of this health still extant on the globe, all of them in places remote from our Western civilization. To those who are attracted by this, at present, novel meaning of genuine health, the author unblushingly commends his little book of a hundred and forty-odd pages, *The Wheel of Health*, in which these examples are also recorded. It is an essential subject to understand for any who feel the need of a reconstruction by way of the soil.

Nevertheless, it cannot be gainsaid that such small and remote examples are scarcely likely to have much effect on those upon whom this reconstruction by way of the soil is now urged. It seems that one is doomed to stir one's readers by the negative proof of the devastation and sickness that the modern era has brought to the soil and the feeders of its products, rather than by isolated proofs of wholeness, health, cheerfulness and well-being.

Before, however, entering upon the long path of negative proof, there presents itself a second positive element of construction, which is complementary to the meticulous care of the soil. This is the form in which the men of that meticulous care served the soil. The form was that of family farming.

The family as a group is but a human complement of the soil itself, both family and soil recreating life. The family is human continuity and the soil is vital continuity. Continuity of the family necessitates marriage as the mode of the bond of the woman to the soil; marriage bringing sons and daughters to the service of the land. It is the land that gave its particular meaning to the farming family; it is its creative power that united itself with the creation of the farmers' children. Marriage, the bearing of children, the apprenticeship of children, the respect of children for their parents and their ancestors, the care that is bestowed by the elders on the present generation because it is to repeat itself in future generations, all this wholeness of life finds its true significance in continuous family ownership or inherited right to the land. It is, then, the land as family property, or in lesser and more dependent degree, the craft as family property, requiring the work of the family for their continuity, which primarily gives stability to men and women making a people.

This right the people of ancient Peru possessed. Their self-governing communities or *ayullus*, settled in ownership of limited areas of land, existed from remote antiquity. They were the basis of the autocratic state, and they themselves constituted an agrarian communism collectively holding the land. The uniting of the *ayullus* was effected by the rulership of the principal *ayullu* or royal family community. By far the majority, too, of the Hunza families -- and the Hunza are also an ancient people -- are freeholders, subject in their unity to the rulership of the Mir. The greatest of these peoples of family farming are our allies, the Chinese. Their empire is by far the most

stable and continuous in the world's history and it was originally founded in the long distant past upon family property or right to the land.

It was to their revered sages that the Chinese have always attributed their Tsing Tien system, the system of the nine fields. A square of land was divided by drawing two lines across it from side to side and two up and down, as in the nursery game of noughts and crosses. Nine squares were thereby formed, eight outer and one central square. The eight outer squares of land were allotted to eight families, the centre square was worked co-operatively and its produce given to the government officials as a tax in kind.

This division into nine squares was symbolic of the principles of the sages. Where it could be, it was, no doubt, carried out. But it was not rigid. The soil is not so similar in character that it can be divided with such exactness. One square might be less readily cultivated than another; one family might be larger than another. So adjustments were made; for example, if one family had several and another no sons, one or more sons of the first might be adopted by the second family. Adaptations were made, but the principal and standard measurements remained. It was considered by the sages as the principle of choice for the reasons that it promoted co-operation, close social relations, mutual production, easy exchange of commodities, unified customs, saving of individual expenses, and it related the work and life of the families to the officials of the nation by the work which the combined families undertook on the central field. This central field could also be adjusted within limits; it could be enlarged or diminished according to the general fortune of the province or nation.

The nine squares within a square symbolized a simple planning and basis of life, which, without doubt, as opposed to change, progress and instability, produced a stability now inconceivable to our Western minds trained in its opposites. We have been accustomed to regard it as stagnation. Since we have become confused and disillusioned with progress and the disasters which it has brought and with which it further threatens almost all mankind including the Chinese people themselves, we have come to think of them historically with more interest and approval, but nevertheless as something so distant and foreign to us that their methods and history cannot really affect us.

Yet, if nature is limited, if man cannot pass certain boundaries or exceed certain controls without entering upon generations of disaster and even human extinction, then some such stable system as that of the Chinese takes upon itself a very different aspect in the measure of human wisdom. It may be that it will then appear as a natural human system, in scale and endurance the greatest achievement in the partnership of intelligent man and nature upon the earth. It was one that long ago attained a certain finality, a completion such as a great art work, a great cathedral or temple reaches. The building needs care, love and daily attendance and sometimes renovation, but it cannot be made more beautiful. It reaches its excellence and, though time may make it more revered and loved, its very excellence shows that it had, from the very beginning, a power of duration within it. A great art has this duration. It is not subject

to frequent change as is science. Changes fail to improve it. Recasting a symphony of Beethoven would not make it more but less beautiful, but the devotion with which it is played supports its beauty as human generations pass.

It is in this sense that we should, I believe, try to estimate and understand the Tsing Tien system. It is a national thing on a great scale *that has kept within the limits imposed by nature*. Through this system the Chinese sages produced and continued a productivity from the soil unexcelled elsewhere, and, from humanity, a community of peasant-family farmers, the largest in numbers, the most skilful, the most contented and the most peaceful amongst the peoples of mankind. The Chinese have, of course, had their misfortunes and occasional catastrophes. They have been beset by people without any settled system such as they enjoyed. Large landowners have from within sometimes destroyed the rights of the peasants, but the Tsing Tien system has been the thread upon which has been threaded period after period of their long history. 'The whole history of government administration of agriculture in China', writes Dr. Ping-Hua Lee, in Volume 99 of the *Studies in History* of the Columbia University, 'coincides with the history of the Tsing Tien system, for it started with this system of land tenure. Its vicissitudes, its crises and epochs were timed by the abolition or re-establishment of the system ... It is fortunate for the economic historian that the history of the Tsing Tien system is coincident with China's political history.'

Thus in the small body of the Hunza and in the large body of the Chinese, much broken by the near past and present havoc, we have rare survivals, instances of skilled and continuous life within the limits that are set by nature and the land; a fitting of skilled mankind into the life-cycle.

The Chinese had not the stupendous secluding mountain wall of the Hunza, but as far as men's power could reach, they made such a wall, the Great Wall fortress, stretching for 1,500 miles to shut out the Tartar. They had not the control of their water supplies from their sources as had the Peruvians and the Hunza; the floods of their great rivers have their origins in huge ranges of stripped hills mostly outside their control. Yet in spite of these foes of secured stability, their system endured until it was finally worn down by the constant attrition of contact with the West. Although it has been the West and its ways that have broken up this system of stability, nevertheless sufficient of it is known, owing to the Chinese historical habit, to see in it the supreme example of the Wisdom of the East in contrast to the Science of the West. The Tsing Tien has been the chief historical system of a human partnership with the soil. In it was secured for century after century the comprehensive range of both the minuteness and grandeur of this partnership, which has by no Western writer been better expressed than by the well-known words of Hasbach in his unique *History of the English Agricultural Labourer*, 1920. 'Trifles', he wrote, 'are the very objects of the small cultivator; he has everything near him and under his eye, makes use of every small advantage, cultivates every corner, has the help of his wife, and brings up his children to be the most useful the country produces. Such men serve the land as it should be served, never stinting themselves, and as absorbed in their service as any priest in his

religion.' Upon this basis stable civilizations of conservation have been and can be built.

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Chapter 6

Farmers and Nomads

I. The Land

Physical maps, showing the different elevations of land, have always had an irresistible attraction for me, and none is more attractive than that of the vast continent of Asia with its European appendage, pushed out like a tongue between the Mediterranean and Northern Seas. What a huge playground of history this map presents! There has been nothing like it in the other continents of the world, Africa Australia and the Americas. They are, excepting Egypt, almost without history, compared to the Eurasiatic Continent.

The map which I possess has five colours to denote different heights, dark green to show land below sea-level, light green from sea-level to 500 feet, yellow 500 to 2,000 feet, light brown 2,000 to 5,000 feet, and dark brown over 5,000 feet.

Asia begins with the beaches of the Arctic Ocean. Then comes a vast light green band or belt with a few yellow areas within it. It stretches right across Asia and Europe. In Asia it is the Siberian Plain; in Europe the Great Lowland Plain.

Except for an extreme northern band of Arctic vegetation, called *tundra*, this light green belt is forest land with great rivers passing through it to the Arctic Ocean. It is Belt No. 1. It has played very little part in Asiatic history.

Yellow-tinted is the land between this green belt and the mountains to the south of it. It has less rainfall than the green land north of it, and is subject to seasons of aridity. It is grass land, the land of the Steppes. This is Belt No. 2. It has played a great part in Asiatic history.

Belonging to Belt No. 2 as Steppe land, there is a patch of light green near the

Caspian Sea. It is a part of the Kirghiz Steppes and it passes directly to the Steppes of south-eastern European Russia; when north of the Caspian, it is actually tinted dark green or below sea-level. This is the Caspian Tract, through which so many hordes of Asiatics passed into Europe in prehistoric and historic times.

The third belt begins with light brown almost from the northeastern tip of Asia. It then shows a dark brown series of mountain ranges. From east to west these are, the long thin line of the Yablonoi Mountains, the much greater mass of the Sayan and Altai Mountains, and the lofty Tianshan, which ends at the seventieth longitude in the Pamir or Roof of the World.

Belt No. 4 is a light brown belt between Belts 3 and 5. It includes Mongolia, the Gobi Desert and Turkestan. It comes to an end at the Pamir. Mongolia is Steppe country and its inhabitants have played a large part in history, not only of Asia but also of eastern Europe. The name Mongol, or Tartar of the Chinese historians, however, has become attached to other peoples of the Steppes as well as to the people of Mongolia.

The filth belt constitutes the largest mass of elevated land in the world. In the east it rises almost abruptly above the light green of the lowland of China, and then forms the most extensive elevation, that of Tibet, 11,000 feet and over, which is inhabited by man. Tibet's southern border is formed by the highest mountains of the world, the range of the Himalaya. The Himalaya pass on westwards, forming the northern barrier of India and join the lofty Tianshan of the third belt in the Pamir.

From the Pamir the conjoint Tianshan and Himalaya continue westwards as the Hindu Kush Range; thence reaching across northern Afghanistan and Persia to arrive at Ararat in the east of Asia Minor. Ranges of lesser height pass from the Hindu Kush southwards to form the eastern border of Afghanistan and then pass west and north-west to the east of the Persian Gulf as the mountains of west Persia and so reach Ararat. They, and the northern ranges, enclose a smaller and much lower plateau than that of Tibet, the Iranian Plateau. Finally from Ararat, mountains continue westwards in Asia Minor, and appear in Europe as the Balkans, the Alps and the Pyrenees.

Belt No. 6 is the land of the Farmers. For our purpose it is the light green land about the great rivers, the Huang Ho or Yellow River and Yangtse Kiang of China, the Brahmaputra, Ganges, and Indus of India, the Euphrates and Tigris of Irak.

Such, in brief, is the physical map of Asia. Its fascination lies in the fact that one can read from it some of the vast progeny of history upon the huge stage of the continent of Asia.

II. The Nomads

The Nomads are the inhabitants of Belt 2, the Steppe country. They are defined in *Annandale's Concise English Dictionary* as 'those people whose chief occupation

consists of feeding their flocks, and who shift their residence according to the state of the pasture'.

The Nomads, according to this definition, present a picture to the mind's eye of wandering shepherds and peaceful pastoralists passing from pasture to pasture to the sound of tinkling cow bells. They would erect their tents of oxhide at new pastures and enjoy the comfort of a home and resting place, until their experienced eyes told them that the pasture was insufficient for their cattle and it was time to move on.

Probably in the earliest historical times, the Nomads had horses. The horse is an Asiatic animal and the only wild horse now known is found in Western Mongolia, as a natural denizen of its dry, open steppes. Certainly the Nomads had horses before 2000 B.C., for horses appeared in Babylonia at that time and two centuries or so later the Hyksos, who conquered Egypt, introduced horses into that country. So we can add the horse to a company of Nomads. But the horse was to them a noble animal and was ridden only. It was not used as a beast of burden as it is to-day; it was the oxen who drew the heavy wagons of the Nomads when they trekked. The horse was loved for its speed. It was the swiftest animal of the steppes and it was this which made it loved by the Nomads.

The picture of the Nomads is a pleasant one and their life was peaceful and pleasant as long as the pasture was good. But, when the rain was scanty and the pasture poor, they were in trouble, Then they had to move frequently and, sometimes, faced by the loss of their cattle by starvation and themselves feeling the pinch of hunger, they would move quickly and their warriors, mounted on their loved steeds and armed with bows and arrows, would fling themselves upon peaceful people, either more fortunate pastoralists like themselves or farmers, slay many and take possession of their land. With their incredible swiftness on the march and an unprecedented speed of encircling attack, with their deadly accuracy of arrows shot from the saddle, with their horrific cries to terrorize their slow-moving victims, they must have seemed like a horde of winged insects, whose sting was death, and whose capture and destruction were impossible.

The cause of this disturbing loss of food was at one time believed to be an increasing dryness of the climate in historical times. This hypothesis was propounded by Prince Kropotkin in an article in the *Royal Geographical Journal* of 1904 in which he stated that it was quite certain that Belt No. 4 was more populated than it is now; it was quite certain, for example, that within historical times Eastern Turkestan and the adjacent part of Mongolia 'were not deserts as they are now. They had a numerous population, advanced in civilization, which stood in lively intercourse with different parts of Asia'. Many of them were successful farmers dependent on irrigation from rivers flowing from their enclosing mountains. This, Sir Aurel Stein, in his monumental work *The Desert Cities of Cathay*, 1912, has convincingly proved beyond further discussion. Kropotkin continued: 'All this is now gone, and it must have been the rapid desiccation of this region which compelled its inhabitants to rush

down to the Jungarian Gate' (Jungaria was a name of Western Mongolia) 'to the lowlands of Balkash and the Obi.' Mr. Huntingdon Ellsworth skilfully developed this hypothesis in *The Pulse of Asia*.

The hypothesis gave rise to very widespread investigation, with the result that, though fluctuations of climate undoubtedly occurred, as shown, for example, by the rise and fall of the level of the Caspian Sea, nevertheless a continuous decline in humidity in historical times could not be accepted. Drives through the Jungarian Gate were, however, accepted.

Another reason had to be found. *It was found in the particular character of the treatment of the soil by the Nomads.*

The first statement of this other reason, which I have been able to find, is that by Monsieur Rorit in the Royal Geographical Journal of 1870. Rorit wrote: 'The nakedness of Arabia and the vast tracts of Asia in the north and west, the sterility, which extends over Persia, cannot be traced to any other cause than the pastoral habits of the inhabitants. The people inhabiting them are locusts; they destroy all woodland and vegetation, modifying even the climate -- whence the necessity of migrations. Had the invasions of the barbarians any other cause? A study of the question in this sense would perhaps give us the key to the great migrations of mankind.'

Monsieur Rorit's reason is pungently expressed, but it is now accepted. It could not well be otherwise, for, to confirm it, the same process is going on in many parts of the world under our eyes today.

In the countries in which Nomads fed their flocks and herds and grew temporary crops of grain, there was, as is usual in uninterfered with nature, a balance between animal and vegetable life. Animals feed upon the land and manure it, but they do not ravage it. When human pastoralists entered these countries, there entered with them an altogether new danger, namely a form of terrene animals so advantaged by their upright position, their hands and their large brains, that they have the capacity to *override the natural law of balance*. They could breed more animals than the land could permanently support; they could break up the natural life-cycle of a district by using all that the soil produced, and then, when exhaustion of the soil came, move on to another district. With weapons forged from the iron of the Altai Mountains, these Nomads could cut down trees and shrubs and, with their ability to create fire from flint or friction, they could burn as well as cut down. The ash of the burnt trees and shrubs gave the manure of their substance to the land and enabled the Nomads to grow good temporary crops for a number of seasons. They, in short, as men, had power; *and power in this sense may be defined as the ability to exceed the limitations set by nature*.

Nature followed the rule of return, and the Nomads, unlike the true farmers, failed to follow the, rule of return. Indirectly, by cutting down trees and shrubs for fuel and for

ash, they made the soil drier. Rain fell and was by nature broken into a fine spray by trees, shrubs and thick grass and was thus evenly and widely spread in the topsoil. The topsoil, sheltered from sun and rain, stored the water. By slow evaporation from the vegetation, the water was returned to the air. But where excess of cattle fed upon the land and where trees and shrubs were widely burnt, the soil was exposed, dried and powdered, and then blown away by the winds or washed away by the rain. So a district of desert was formed, which forced the Nomads to move on. Nature then returned and in many cases restored the ravage. But if the destruction of fertility had been too great or if the half-recovered soil was again used for crops and grazing, permanent deterioration was the result.

The Nomads, then, lived a life of ill-balance by not following the rule of return, which is *the only stable rule of living*. They were, therefore, forced to live a life of *chance*. They depended on the seasons and, as the seasons varied, they themselves were necessarily *speculative*. In this character, indeed, they were like to other kinds of speculators, many prominent at the present time. Speculators disregard the rule of return. They strive to gain without giving; they disregard future generations; they are indifferent to the sufferings of others, provided they themselves can escape suffering. Yet eventually there is no escape from the effects of these actions, because ultimately their values are destructive and not conservative.

As long as the Nomads failed to use settled agriculture and limit their cattle-breeding, life was sometimes generous to them, sometimes even-handed, sometimes, at seasons of drought, harsh. At times of harshness, mounted on their horses they organized wide-sweeping hunts of wild animals for their food. If further pressed, they were forced to move on and this sometimes entailed making raids into the lands of their neighbours, who, in their turn might raid or join with them in raiding. Then, with increasing numbers, they might successfully, make themselves masters of the land of settled farmers and the food and wealth, which they had not the wit to get by their own skill and toil. Hence they praised war, not as a means of defence in the way in which a sturdy peasantry has so often successfully defended itself and its soil, but as a means to mastery and wealth. To them life was not only a struggle for existence, but a will to power over their enemies, an assertion of the right of the better-armed and of the more savage nature over what they regarded as possible, and if possible legitimate, prey. They terrorized when they attacked, and, when they conquered, they were successful owing to the speed of their attack, the terror they aroused, and the human slaughter they effected. All these characters of theirs ultimately, therefore, arose from their attitude to the soil. *The soil was something to be exploited and even plundered for their gain*. This attitude was in the sharpest possible contrast to the tenet of the Babylonians, that the soil belonged to their god, or to the sanctity with which the soil was endowed by the followers of Zoroaster. *These faiths of the holiness or wholeness of the soil were, as we shall see, faiths of the farmers*; the very word cultivate is derived from the Latin verb *colere*, of the two-fold meaning of tilling and worship.

Yet the Nomads were not by any means always wild horsemen, as when they presented themselves to their enemies, the farmers. They had within them the gentler character of humanity. Professor Keane, in *Man, Past and Present*, said of the Tartars or Mongols of Mongolia: 'They are all brave, warlike, even fierce, and capable of great atrocities, though not normally cruel.' The invention of the gun has now robbed them of their power and, in consequence, they have 'almost everywhere undergone a marked change from a rude and ferocious to a milder and more humane disposition.'

The Nomads have been *the great human desert-makers*, and the deserts of the Gobi, the Lop Nor, the Taklamakan, the Registan, the Great Salt Desert, the Syrian Desert, and even the Arabian Desert and the Sahara of Africa are due to their treatment of the soil. Nor is this desert-making by men at an end. It is going on at the present, as future chapters will show, in North and South America, in Russia, in Asia, in North and South Africa, in Australia, and even in the islands of New Zealand and the West Indies, with a speed that outstrips that of the Asiatic Nomads, so much so that it may even be said that man, in this proud scientific era, has paid for his all-too-swift advance by the loss of terrene capital, of the fertility of the soil. He has become the great transferrer of this capital to other fields than those of the soil, and, by his destruction of the soil, has foredoomed himself to God knows what impending calamities, exceeding those brought about by the Asiatic Nomads, unless he calls a halt.

It is this fact which gives this dissertation on the Nomadic character its present significance.

III. The Farmers

Belt No. 6 of Asia is the belt of the Farmers. From the mountains of Belt No. 5 great rivers run southwards into the Persian Gulf, the Indian Ocean and the Pacific Ocean, and along these rivers the Farmers built up their civilizations. The first civilization we shall take will be the one that is believed to be the oldest of them with the doubtful exception of that of China. It is that of Iraq.

This civilization was, *par excellence*, the civilization of irrigated farming. The rivers upon which it built itself were three, the Euphrates, the Tigris and the Karun. All three rivers, throughout its duration, discharged their waters separately into the head of the Persian Gulf. To-day the Karun joins the Tigris, and the Euphrates and Tigris have one joint mouth 140 miles to the south of where the three mouths then met the sea.

The first river of the three to form a basis of civilization was the shortest and the most eastern, the Karun, with its important tributary, the Ab-i-Diz. These two rivers ran through flat alluvial country before they reached the sea. Their courses in the flat land were brief compared to those of the Euphrates and the Tigris, their major lengths being amidst the mountains, through which they dashed down. Elam, as was the name of this country, therefore, resembled Latium, having a plain near the sea, and a great

capital, Susa, situated on the plain within thirty miles of the hills. The civilization of the farmers and hillsmen of Elam preceded that of the Latins by some three thousand years. Elam showed much of the tenacity of Rome, for mostly it kept its independence and played a considerable part in the riverine civilization of Iraq for a period of some 2,000 years.

The riverine civilization was further developed by Sumer, Akkad, and Babylonia, with their City-States watered by the sluggish Euphrates. The Tigris was swifter and more steeply banked and, therefore, less used. The Akkadians and Babylonians were men of the Semitic Race. The Sumerians were of doubtful origin. They were believed to have preceded the Semites, and to have been the inventors, about 3500 B.C., of the cuneiform writing later adopted by the Semites and found upon the baked clay tablets, the excavation and deciphering of which have enabled scholars to extract from the sites of the City-States the history of this artistic, flourishing, powerful and very ancient civilization of irrigated farming.

The City-States consisted of the cities and the pastures of the cattle, together surrounded by walls, and of the farmed land outside the walls. The life of the land depended solely on irrigation and it was the ambition of good rulers of the City-States to cut out a new canal and clean out the old ones. The early history of the tablets records such work, the building of temples and the wars carried out by the cities against each other, wars to establish suzerainty, but not in any way to injure the farming of the soil, upon which all depended for their existence. Eventually Babylon became paramount. Babylon's first dynasty is given as beginning about 2400 B.C. Babylon was conquered by the Persians under Cyrus in 538 B.C.

Lastly in the accumulated centuries of this riverine civilization came the Assyrians, also a Semitic people, appearing in the thirteenth century. They inhabited the land of the middle reaches of the Tigris.

From the level of Hit on the Euphrates, a little to the north of the modern Bagdad on the Tigris, the land for 550 miles to the Persian Gulf is purely alluvial, with all the advantages of alluvial soil, such as lower Egypt enjoys from the Nile, Bengal from the Ganges and the Brahmaputra, and the Chinese in the lower reaches of the Huang Ho and Yangtse Kiang. Above Hit there is a reef of hard rock from which to the north the land continues to be rocky. For this reason the Assyrians, with their capital at Kalaat Shirgat on the Tigris about 200 miles to the north of Babylon, were not so favoured as the southern alluvial peoples, and therefore exhibited what Sir Percy Sykes, in his *History of Persia*, calls a predatory character. Their initial strength, says Sykes, lay in the formidable fighting quality of a free agricultural class. When this class became exhausted, the Assyrian rulers moved their capital to Nineveh on the opposite bank to the modern Mosul, near where the Tigris enters Iraq from the mountains of the south-eastern corner of Asia Minor. This gave them the control and use of sturdy hillsmen as mercenaries. The Assyrians, as northerners, became masters of the southerners of Babylonia in 745 B.C. and remained so until 606 B.C., the brief period

of about a century and a half which is so constant in the case of inferior conquerors. In 606 B.C. the Medes, with the assistance of the revolting Babylonians, sacked Nineveh. So great had been the cruelty and barbarity of the northerners compared to the southerners of Babylon, that Sykes declares: Assyria 'shone only as a great predatory power, and when she fell, passed away into utter and well-merited oblivion'.

Assyria's predatory character introduces us to the Aryans, for the Medes were Aryans, living in the valleys of the Zagros Mountains, and the adjacent Iranian plateau in the north-west of Persia.

The Aryans entered the north of Persia about 2400 B.C. and the Medes about 2000 B.C. They were steppe dwellers, as their language, in its omission to speak of forests and mountains, discloses. They came as Nomads with flocks and herds, moving their habitation from place to place with the help of large wagons.

The Medes, at the time of Assyria's ascendancy, were subject to predatory raids by the armed Assyrian forces; and the results of these raids show the Medes as a more settled people than were their nomadic ancestors. 'From the frequency with which these expeditions raided the Iranian plateau', writes Sykes -- the plateau that is to-day so desolate -- 'and from the number of towns they destroyed, it was then a distinctly fertile and well-populated country. The inference is confirmed by the number of prisoners and the thousands of horses, cattle and sheep that were captured.' Thus in one raid in 744 B.C. 'the success of the campaign may be estimated from the fact that 60,500 prisoners and enormous herds of oxen, sheep, mules and dromedaries were led back in triumph to Calah', near Nineveh.

These afflictions brought about a desire for vengeance in the Medes. They were sturdy hillsmen and unexcelled horsemen. Under Cyaxares, their great leader, they circled round the Assyrian soldiers just beyond the range of their weapons, and poured a ceaseless shower of arrows into their midst. With the help of the Babylonians, they destroyed the Assyrian Empire in 0o6 B.C.

The Persians entered eastern Persia from the steppes to the north of Khorasan in what is now Russian Turkestan and, traversing the south-eastern Persian province of Kerman, reached Fars, with the Persian Gulf as its western limit and Elam and the Medes to the north. At this time a notable event happened, which illustrates the soil character of the Medes and Persians. They both adopted the religion of Zoroaster, who was born 'about 660 B.C. or perhaps a few generations earlier' (Sykes), and therefore some half a century or more before the destruction of the Assyrians. Zoroaster raised the use of the soil to the first place in the three chief tenets of his religion. His first tenet was: '*That agriculture and cattle-breeding are the noble callings*.' 'He who sows the ground with care and diligence', he announced, 'acquires a greater stock of religious merit than he would gain by the repetition of ten thousand prayers.'

A further illustration of the character of these farming and pastoral peoples in the highland of Western Persia is shown by the remarkable fact that Cyaxares and his Medes did not take possession of the wonderful riverine civilizations of Iraq after the sack of Nineveh. They were content to hand it over to their allies, the Babylonians, who then erected the brief but brilliant Tenth Dynasty. Cyaxares, however, did not cease from his conquests, but confined them to the uplands of Persia, Armenia, the upper reaches of the Tigris and western Cappadocia.

One of the greatest of Aryan leaders, the Persian, Cyrus, defeated the son of Cyaxares by taking Ecbatana, the modern Hamadan, and the capital of the Medes, in 550 B.C. Cyrus became the first king of all Persia and proceeded to make himself master of the most extensive empire the world had then seen. From 500 B.C. to A.D. 600 Persia must have denoted an area more than half the size of Europe. The Medes were not made the subjects of Cyrus, but his brethren in religion and status. He overthrew Croesus in 546 B.C. and became master of the Greek colonies in Asia Minor. He took Babylon in 538 B.C. So the early Persian conquests, it seems, were not based on the strength in food of Iraq. By becoming the master of Iraq, Cyrus brought the independence of its riverine civilizations to an end.

Now, this long story of the riverine civilizations, enduring as it did for thirty centuries and only surpassed by the forty centuries of China, illustrates the *extraordinary stability of a civilization founded upon the soil as its first principle*. The City-States of Babylonia regarded,the land as sacred. Each state had its god and, writes Mr. C. H. W. Johns, in *Ancient Babylonia*, 1913, 'the god was the owner of all the city land, its *belu*, or "Lord".' The priests acted as his agents. Sykes terms it 'a feudal, ecclesiastical system', but the fact remains that *the soil was regarded as sacred*. This sanctity was revived by the followers of Mohammed, when they became masters of Iraq.

A second notable fact of the thirty centuries of the civilization founded on farming was *its freedom from destruction by the Nomads*. Only once, in Sykes's record, did Nomads threaten its independence. That was the invasion of Iraq by the Semitic Aramaean hordes from Arabia. They apparently took the whole of Assyria, and brought the Eighth Dynasty of Babylonia to its end. They were eventually subdued by the Assyrians. With this exception and a brief raid by Scythians, sent against the Medes by the failing Assyrians, *the factor of the invasions and conquests of Farmers by Nomads*, which played so large a part in history, did not greatly affect the strength of the organized societies of the Farmers. It is to its vast effects on history that we must now turn.

IV. Nomadic Migrations and Farmers

The first great migrations of the Nomads occurred between 2500 and 2000 B.C. During that time Aryans, as we have seen, reached the Iranian Plateau. It was the time of the First and Second Dynasties of Babylon, and apparently had no effect upon the

highly organized riverine civilizations.

The second migratory period was about 1500 B.C. It was the time of the overthrow of the early Minoan civilization of Crete by the Dorians, the conquest of Egypt by the Hyksos and the disturbances of the first dynasty of China, the Shang, 1750-1122 B.C., by the Mongolian, Hiung-wu.

The third migratory period was about 1200 B C. It was the time of the invasion of Greece by the Dorians and their destruction of the later Minoan civilization, and the end of the Shang Dynasty of China brought about by the Hiung-wu.

Neither of these two periods of nomadic migration affected the riverine civilization of Babylonia. The Kassites, who formed the Third Dynasty of Babylonia (1700-1170 B.C.) and came from the Zagros Mountains though originally, perhaps, nomadic Aryans, were not at this time nomadic, but a settled people like those of Elam, their southern neighbour amidst the hills.

The fourth migratory period witnessed the virtual fall of the Chow Dynasty in China in 659 B.C. The same movement brought the Sesunaga to India in 620 B.C. They established the Magadha Kingdom in the central and eastern Gangetic Plain. Possibly contemporaneous movements in Europe were those of the Celts into the middle valley of the Danube, and from there at a later date into France, Spain and Northern Italy.

The remarkable fact, then, about these four great migratory periods of the Nomads is that they had little or no effect upon the first and perhaps greatest Asiatic farming civilization, though they were so destructive to other lands and peoples. The Persians who succeeded the Babylonians, in 538 B.C., were no less strong. They were Zoroastrians and Zoroaster taught the high significance of farming. From the time of Cyrus and for a long period later, Persia offered an almost invincible obstacle to these movements of the Nomads of Asia, diverting them to India to the south and northwards to Central Turkestan and Europe. Persia fell to Alexander of Macedon and after his death the Seleucids reigned. They were replaced by their pupils the Parthians of Khorasan, like the Persians an Iranian people, the words of Arya and Iran having the same derivation. The Parthians, in their turn, gave way to the Persian Sassanian Dynasty, and the Sassanians to a people who rapidly became great farmers, the Arabs of Islam. The, significance of this barrier-power of Farmers against Nomads is very great indeed. It began with Babylon's first dynasty, nearly 2400 B.C., and it endured until the overthrow of the Arabs by the nomadic Mongols in A.D. 1258, a total of some four thousand years.

The next great farming people of Asia were the Chinese, and they can also claim a history of four thousand years. Professor F. H. King, who quite recently wrote his famous book on their agriculture, called it truly *Farmers of Forty Centuries*. The first location of the Chinese was along the Huang Ho or Yellow River, which arises in the highlands of Tibet, as does their second great river, the Yangtse Kiang. They settled

upon the lands along the Huang Ho after it makes its right-angled bend from east to south in the fortieth latitude. The Nomads, who so frequently threatened this otherwise peaceful people were called by them the Tartars, and by us the Mongols and their country Mongolia. The Chinese are historically-minded. They begin their history with the Emperor Fuhi (2852-2738 B.C.), who is said to have founded the large or patriarchal family system. In the reign of the Emperor Huang-ti (2704 or 2491 B.C.), the northern Mongols receive their first mention under the name of Hun-yu. The date of the first definite dynasty, the Shang, is given as 1766-1122 B.C. In their time, Chinese history was mainly one of peace, but towards the end of their period, the Mongols, known now as Hiung-wu, appeared, and it is said that it was with their help that the Shang Dynasty was overthrown by its successor, the Chow (1122-659 B.C.). The Chow and the Shang Dynasties together reigned for a thousand years. In this length of time, they resembled the Babylonians.

When the Chow Dynasty came to an end, a general unity ended with it. Various states, especially the border states, asserted their independence and fought together for suzerainty. It was in the period of Contending States, as the Chinese historians call it that, from 551 to 479 B.C., the most famous of the Chinese, Confucius, lived.

Another very famous Chinaman changed the complexion of the Contending States. He was the Emperor Chin Chi Huang-ti, who ruled from 249-210 B.C. This Emperor united the Chinese, and to shut off the invasions of their troublesome neighbours, the Mongols, he built perhaps the most prodigious Maginot Line mankind has ever witnessed. This immense fortified Great Wall stretched from the sea to the north of Pekin for 1,500 miles. Nor did the Emperor's energy exhaust itself in this brobdingnagian undertaking. He drove the Mongols out of Inner Mongolia, on the borders of China, into Outer Mongolia, and the Early Han Dynasty (206 B.C. to A.D. 23) continued the aggression. Then occurred one of those remarkable shunting-train movements which the Chinese in an aggressive imperial mood originated. The driven Mongols and Turki-Mongols retreated westwards, forcing other peoples before them. Some of these peoples, continuing westwards, conquered the Greek Kingdom of Bactria-Sogdiana between the Hindu Kush and the Sea of Aral; others turned south and eventually passed through the Bolan Pass and invaded the land of Five Rivers, the Punjab. The Early Hans annexed Mongolia and Eastern Turkestan, and Bactria and Sogdiana were compelled to acknowledge their supremacy. Any further conquest was then stopped by the barrier of organized Persia.

The Hans, early and late (A.D. 23-230), bring us to the Mongol or Nomadic movements of our own era. A great Mongol movement brought about the downfall of the Western Tsin Dynasty in China in A.D. 419. The Gupta Dynasty in India was overcome by the White Huns in A.D. 450. These White Huns also for many years harassed the Persians, but were eventually destroyed by the power of the Sassanian Dynasty. The date of the movement under Attila the Hun, who reached Rome, is given as A.D. 445-453, and caused the Slavs to push the Teutons into Britain, France, Austria and Lombardy.

The Chinese, under the short Suy Dynasty (A.D. 590-618), and the Tang Dynasty (A.D. 618-907), in its early period, launched an imperial recoil movement and by A.D. 640 had again conquered Eastern Turkestan and extended their influence as far as Persia and the Caspian. The Arabs in Persia checked their threat to Persia about A.D. 650.

A further Mongol movement brought the Tang Dynasty to an end in A.D. 907 and sent the Turki-Mongol Ghazni Dynasty into North-western India. The Magyars entered Europe and divided the Slavs into northern and southern Slavs.

The vast Mongol and Turki-Mongol movements under Genghiz Khan and his successors occupied the thirteenth century. China was conquered. Northern India was conquered. The Arab power was broken in A.D. 1258. Assaults were made on the Byzantine Empire, and southern Russia was conquered and occupied.

The latter half of the fourteenth century witnessed the peculiarly personal achievements of the greatest of Asiatic conquerors, Tamerlane (A.D. 1335-1405), the Turk. No ruler of the time was able to oppose his supreme genius with success. He was not destructive and murderous as were Genghiz Khan and his successors, but supplanted the established rulers by conquest. He was, wrote Sykes, 'profoundly sagacious, generous, experienced and persevering ... In *The Institutes* it is laid down that every soldier surrendering should be treated with honour and regard, a rule which, in striking contrast with the customs prevailing at the period, is remarkable for its humane spirit.' As a consequence no marked change occurred in the habitation of peoples.

The last two Mongol movements were conquests and changes of dynasty without any general effect. The first was the Moghul conquest of most of India (Akbar, A.D. 1556- 1605); the second that of the Manchu conquest of China in A.D. 1644.

Such, in outline, was the historical effect of the Nomads of Asia. A full account of these movements, the history caused by them, and the numerous dynasties founded by them in Asia and in Europe, mostly to endure only about a century and a half, will be found in my *Causes of Peace and War* (Heinemann, 1926).

Here let us close the physical atlas, and this long chapter, which it is hoped will convince readers of a dependence of much war and history upon men's attitude to the soil. At present it is a subject mostly ignored by the historians, but I hope that soon some great modern scholar will deal with the subject more adequately than I have been able to do. Perhaps it will give rise to a greater knowledge of the causes of devastating wars and their prevention. Perhaps it will show that home-farming establishes in each nation a class strong in its desire for peace, and that, as in the past the Nomads were the chief enemies of peace, so the nomadic type is still prevalent and powerful, and still sees in war the means of its advantage. The social elimination of these advantages and a true valuation of the soil may then prove powerful factors

in the maintenance of peace.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 7

Contrasting Pictures

In order to get a clear idea of the modern valuation of the soil and its effects, it is well to begin with the opposite of the unavoidable sketchiness of a trans-continental survey, such as that of the last chapter, and to concentrate upon self-contained examples on a small scale. Small islands offer themselves at once as the opposite to great continents. By nature they are self-contained. Their inhabitants get food from the sea, a source with which they are unable to interfere as they can with the soil. Sea-food, therefore, has the natural quality of wholeness. Health, therefore, should be found in such islands.

It is never vain to ask health from nature, and small islands still preserve to a large extent this gift, or certainly did until trade intervened. The health of the few inhabitants of that most isolated island, Tristan da Cunha, was described by a medical visitor in the *British Medical Journal*, March 1938, as 'vastly superior to that of the civilized world'. Similar health distinguished the inhabitants of the once isolated Iceland and the Faroe Islands. The health of uninterfered-with South Sea islanders affords further examples.

This whole health is shared by all forms of life and is preserved whilst the island is a self-contained life-cycle and the rule of return is followed automatically. But, when trade enters and breaks the rule of return, then a deterioration of life sets in. This has happened in the Falkland Islands in the South Atlantic. There are many islands, but only two of any size. They run parallel to each other and are some 100 miles long. These islands came into the hands of the British over a century ago. Bleak and almost treeless, they nevertheless possessed vegetation upon which sheep and cattle could feed. So these animals were imported and bred for the British market. The venture was a success, but in course of time there came evidence that the way in which the trade was conducted was inimical to the life-creating soil of the islands. Sir John Orr, in *Minerals in Pasture*, described what this was: 'Munro reports that in the Falkland

Islands sheep have been reared and exported for forty years without any return to the soil to replace the minerals removed. During the last twenty years it has become increasingly difficult to rear lambs. The other animals are also deteriorating.'

The sequence or story is a very simple one.. There are these two islands, which have their own life-cycle. They became British and Britons imported sheep and other domestic animals to the islands. These animals were not predatory. They belonged to the grazing animals, which all over the world feed on grass and other herbage and do the soil no harm. Presumably, then, they could have been added to and supported in the Falkland life-cycle without doing it any harm, if, as just part of that cycle, they grazed and at the same time returned to the soil again what they took from it in life and finally after death. The story does not, however, run this good and happy way; it, like so many primitive stories of life, has its demon. In this case the demon quite probably lives in Liverpool, and he shows his demoniac quality in buying the Falkland sheep, having them shipped to Britain for the Britons to eat their flesh and spin their wool. He is not a demon of commission but of omission. This is what he and his like effect in the words of Sir John Orr: 'The process of depletion and the resulting deterioration which shows itself in decreased rate of growth and production, and in extreme cases by the appearance of disease, is proceeding on all pastures from which the milk, carcasses and other animal products are taken off without a corresponding replacement being made.' In Britain itself domestic animals are reared and then sent off to industrial areas without replacement. 'In our own country this process of depletion has been going on for many years, especially in hill pastures, and it is probable that the recognized decrease in the value of hill pastures in certain areas, owing to the increase in the diseases and mortality of sheep, is associated with the gradual process of the impoverishment of the pasture and its soil.'

The sheep want to get their full share in the life-cycle, but they cannot. The minerals are not there, for they left the life-cycle when the sheep's ancestors were deported to industrial areas. Precisely the same has happened in the Falkland Islands in the distant South Atlantic; and in both places it happens for the same reason, that the men, who own both, put money before life.

This is known with the half-conviction and half-knowledge, which are part of the famous facility for compromise of the trading race which owns them. In certain grazing areas, a form of return is given, which again forms a trade. The pastoralists or their employers buy the chief minerals, which the soil loses, from other men who mine and excavate them, and these imported minerals are put into the depleted soil. It is something to the gain of the soil for the time being and maybe this is being done to the Falklands. I have no information on the subject, but it is possible that phosphates from the South Sea island of Nauru eventually reach the soil of the Falklands.

Such a return would occur, and does occur in a great number of places, *not as a following out of the rule of return, but from an almost absolute necessity because the rule has not been followed*. Were it followed, there would be no need of any

reconstruction of the treatment of the Falkland Islands, nor to state how it would have to be carried out as a reconstruction based on the soil.

The herds kept by the British in the Falkland Islands constitute the biggest animal feeders upon the herbage. The herbage draws its minerals from the soil, and these minerals pass into the bodies of the cattle. When those bodies, either alive or as carcasses, are taken out of the islands, then so much of the minerals of the soil as they contain are taken out of the islands. They arrive in Britain and there these minerals enter into the bodies of the British, who eat the meat of the animals. The British are, in brief, eating up the soil of the Falkland Islands. To fulfil the rule of return, when ships take the animals to Liverpool or London, ships should take back their equivalent in food for the Falkland Islands to Port Stanley. This is no more impossible than it is for iron to float upon the water and form the ships in which the food travels. It is only a question of values. If the *condition of the soil were the valuer*, this would be done. If health were the valuer it would be done. If the *economy* of health and quality were the valuer, it would be done. It is not done, because under present values, a number of people actually profit from the ill health of a far greater number, their methods of business being inseparably involved in the breaking of life-cycles and consequent ill health and its social complications. The buyer buys the products of the small islands, but he gives back only something abstract, namely money; he has no duty to give back anything more than his money. Further, the owners of the Falkland products exchange them for money and they also have no duty to life in the form of the rule of return. They may be forced to buy some sort of manure for the land, but they do this under pressure of the land's depreciation. But as long as they can sell the minerals or stored fertility of the Falklands to Britain for money, they do so without any pricks of conscience as regards the effect of their deeds upon the quality of life. It is, in short, an astonishing anomaly that they who ship this life to Britain, in doing so, each time actually commit murder on a certain quality of life in the Falklands. They become ultimately as dangerous to the pastureland as the pastoralists of the last chapter, and, indeed, being more powerful in means than they, correspondingly more dangerous.

What could be ensured if the rule of return were followed? This can be answered by a consideration of a contrasting picture to the Falklands, a yet smaller microcosm than the islands, actually a dairy farm. The one I propose to review suits my purpose well because it was a deliberate reconstruction based largely on the rule of return.

The farm of 165 acres only is situated within a hundred miles of the southern shore of the Baltic Sea, in a land of heath and pinewoods and an unfavourable climate of heavy wind and low rainfall. Its story starts with failure. In spite of importing sound cattle and feeding stuffs from outside at considerable expense, the farm fell, where sick farms and industries do fall, namely, into the hands of a bank. But the bank failed to make it flourish and eventually it came into the hands of a farmer who believed that to get a sound and healthy farm it must be a self-contained unit within the countryside itself. The beasts had to get their health from the soil on which they lived and not from outside, and they had to give back what they took from it. He proposed, as it

were, to put a circle round it and that circle was to be a magic circle. Its magic was to be the aboriginal strength of the soil. A self-contained world of plants, animals and insects was to be brought into being and the balance that nature produces allowed to give its wholeness or health. The faith of the farmer was that only when the cattle bind their whole nature with the soil that nourishes them can they and the soil unitedly reach their full strength.

Everything was planned as a whole, but for the purposes of description the parts will be taken separately. Firstly comes the soil, Its chief needs were water, protection against wind, and food. Water depended upon the annual rainfall and this was some thirteen to seventeen inches yearly. More rain could not be got, but shelter helped to prevent evaporation, as shown in the woods and heaths, which were the uninterfered-with vegetative cover of the land. So the growing of trees and hedges with their double use of protecting soil by their above-ground growth and connecting soil and subsoil by their below-ground growth. Trees also gave a homeland to birds, and hedges to flowers, hedgehogs, lizards, hens, hares and a varied world of insects, all of which were neither encouraged nor suppressed, but allowed by the knowledge that in free instinct each form of life seeks its sustenance from and gives its quota to the whole, which in natural balance is health.

Then came the cultivated plants and these were chosen for the food of the animals, a smaller part for the humans and a larger part for the domestic animals. The plants for the animals were so chosen that food from the soil was available all the year round. Where special protection for finer foodstuffs was necessary, a terraced garden was devised for their growth. When use had been made of the edible part of these plants, the rest was rotted into manure by a process of composting with the dung of the animals and so returned to the soil. Nothing went off the farm except the milk and the occasional sale of a young animal in later years, when their vigour became celebrated.

We can now form a picture of what this farm became. It became, in its having as far as possible a setting in the original nature of the land, an aboriginal farm. But added to this was the skill and knowledge of specially trained men. It was a farm which deliberately reintroduced the methods of nature in uncultivated lands so as to regain nature's health and strength. It was a declaration that *it is never vain to ask nature to give health to the work of those who know what health is.*

The results were termed miraculous. The healing brought about certainly makes one think that the miracle is not in nature being able to create health, but that so few westerners know it. Here are the conditions before and after the miracle. When the dairy farm was started on the new lines, the herd of cattle suffered from contagious abortion, and were strongly tuberculous. A number of the animals had to be destroyed owing to tuberculosis, and it was even debated whether it would not be better to destroy the whole herd to get rid of tuberculosis, contagious abortion and other diseases once and for all, and buy a new herd. But the faith that works miracles was present. Out of the sandy floor came a fount of animal health. The one-time sick herd

acquired a new health. The new methods required understanding, hard and sacrificing work. But the result was that on this new shut-off and self-contained farm the soil revealed its surprising gifts.

The young plants took upon themselves a new being. They now were healthy and reproduced abundantly. The seeds that they bore were seeds which the sandy soil welcomed; they were just the right seeds being in the same cycle as the soil itself. The plants looked well and the fodder straw preserved its beautiful golden colour. The plants grown for human use yielded foods notably rich in taste. The animals in their qualities accompanied the plants. They became healthy and fertile instead of sick and infertile. The cows gave more abundant milk and the young cows born on the farm doubled the output of the past milkers. The milk itself was rich in taste and acquired a special market amongst invalids, who enjoyed its taste and experienced its nourishment. Particularly noticeable, because of the eternal charm that belongs to healthy youth, were the generation that were born into this life-cycle on the farm. At birth the calves at once sprang up and showed a lively temperament. They grew strong limbs and glossy coats. Rather surprisingly they contradicted the dictum that soils poor in chalk produce poor bones. These calves built notably strong bones upon their chalk-poor soil. That other weird fact, which in itself seems to partake of the miraculous, that rays from the sun upon the skin of beasts assist powerfully in the use of chalk, came into its full operation so that such chalk as the soil had was economically excellent chalk. Every particle of it fell into its right place in the cycle, and, as an outward and visible sign of it, owners of neighbouring farms came to inspect the calves, felt their strong limbs, admired their vivacity and delight in life and readily bought them when for sale to increase the strength of their own herds according to the accustomed manner, which the farm itself had been able to abandon.

So we have these two contrasting pictures, the picture of the Falkland Islands, where the cattle showed such marked deterioration and where they were difficult to rear, and that of the sick farm which became a fount of animal health. The similarity of health and wholeness of the farm is unmistakable. Health is a positive quality and I do not know how else it can be obtained or maintained except by wholeness in the cycle of life. Nutrition diets, vitamins, protective foods are not wholes. They are only selections of one factor of a cycle, the factor of human food. If they are given the claim to produce health, which is a whole, it is a claim which will lead men, or mislead men, to further disappointment. Health is now being particularly pursued by a nutritional avenue as well as by the anti-microbic sanitation avenue. But when the whole is the aim, the fragmentations which are sought by these avenues, the specific microbes, the antiseptics, the sera, the vaccines, the great chemical remedies which now compel the admiration of all, the vitamins, the minerals of food, the protective foods, the hormones -- all become unessentials, being absorbed by the positive whole, in which even the microbic world loses its negative and dangerous character and becomes positive and beneficial. Negatives vanish and positives take their place. The world, as fashioned by men, undergoes an enormous simplification. The scores of diseases of men and the animals and vegetables they farm constitute an immense mass of negatives, the elimination of which would alter the very aspect of life. At

present we are pushed to a host of discoveries, inventions, and health, and even life-destroying creations, because the simple contrasting pictures, which figure in this chapter, have not been seen at all by the vast majority and not seen with lively vision by the few. We shall now review further happenings in the wide world brought about by the alienation of men's minds from the creative power of the soil.

Chapter 8

Banks for the Soil

The traders of England take living matter in the form of cattle from the soil of the Falkland Islands, pay money for it to the Falkland farmers, but pay nothing at all to the living soil itself. The reason for this is that there are no banks in Britain for the soil of the Empire, though there are plenty of them for the farmers of the Empire.

What the soil needs as payment for its share in the production and feeding of the cattle is not, of course, money. It does not want *symbols of reality; it needs reality itself*. Unless it has this reality, it becomes less and less able to carry out its part of the partnership between it and the Falkland farmers. So it must have a payment in its own currency, that of soil-food-substances, and not in the currency of men.

It is true that the currency in which the farmers are paid could be turned into one factor of soil-food by means of a further trading transaction. The farmers, for example, could with the help of their banks buy phosphates from the island of Nauru in the Pacific Ocean and give it to the Falkland soil to make up for the phosphates that were taken out of it in the bodies of the exported cattle. But this transaction, being carried out by traders' money-banks, would not prevent the final loss of the phosphates of the Falkland' soil. These phosphates would, in the absence of banks for the soil in Britain, just go down the drain; in other words, they would first be eaten as a part of beef or mutton by some people in Britain, made use of by them, be passed by them as excreta into the drainage system and, through it, eventually reach some part of Britain's Atlantic girdle. So, from the world of terrene men, these phosphates would be dispersed into the vast, dark world of the waters of the sea.

With banks for the soil in Britain, however, the story would be very different. Not only the phosphates, but all the life substances of the Falkland soil would be collected by the banks for the soil and paid back to it, just as the farmers' banks collect the money due to the farmers and pay it back to them. The banks for the soil would, in brief, follow the rule of return. They would do for the Falklands, what they would also do for all exporting countries, the products of whose living soils were imported into Britain. They would collect all forms of imported soil substances after use, make them into soil-food and return them to the exporting countries. Thus the balance of life, which is far more important ultimately than is the balance of trade, would be preserved. As it is, in this age of commercial values, nothing at all is done; the

benefits of trade are split off from life itself as a whole, and, quite unconsciously, the traders become the enemies of that life. They actually destroy that upon which their own very wealth depends. They impoverish the soils and in the end will so degrade them that trade will come to an end. Even the soil of the huge cattle estates of the Argentine, which send far more animal food than the little Falklands to Britain, is known to be deteriorating.

It is, then, where traders and other business men are most concentrated that the need of banks for the soil is most urgent; it is there that the wastage of the currency of life substances is most colossal; it is there that the knowledge of this wastage is so meagre as almost to be entirely absent. Britain, as an importing country in particular, takes large quantities of raw material for food, clothing and manufacture from foreign soils. The towns of many other countries do likewise. The result is that export trade in terms of the life-cycles, entails a great transfer of the elements of life from one country to another without return, or, in other words, a slow bleeding of the exporting countries. The importing countries are seen as leeches or other blood-sucking parasites harboured, all too willingly, by the exporting countries. With vast territories the exporting countries will enjoy a long spell of prosperity founded upon a primal high fertility of the soil, but the end is inevitable, a loss of the wholeness of its life-cycles, partial or complete spoiling of the land, erosion, flood, swamp, even barren hills and desert, degenerate plant and animal life, human depopulation and poverty, disease, and other sequels of the loss of soil fertility.

In reconstruction, this loss of the fertility of the soil, due to the wrongful values of commercial dominance, can only be met by banks for the soil. It is not a question only of whether life can be healthily carried on without them, but of *whether it can be carried on at all*. In 1896 Professor Shaler of Harvard gave a very clear and ominous reply to this question of questions:, 'If mankind', he said, 'cannot design and enforce ways of dealing with the earth which will preserve the sources of life, we must look forward to a time -- remote it may be, but clearly discernible -- when our kind, having wasted its great inheritance, will fade from the earth because of the ruin it has accomplished.' That is the startling fact, with which the neglect of banks for the soil faces the peoples of the era of progress.

The Falkland Islands are very small and very distant. Their loss to the modern world would make little difference. They do but present an infinitesimal part of a wastage that is going on on a truly enormous scale. Of this wastage, let us now take one of its chief examples, that of the wastage of human sewage.

Everyone knows that manure can be turned into food by the soil, and in nature is returned to the soil. Yet the waste of potential manure is prodigious. The dictionary definition of waste is 'resembling a desert'. Yet what is called waste does not resemble, but is the opposite of the desert. The desert is *out* of life. It is modern water-carriage sanitation that takes the elements essential to human life and puts them *out* of life, and then calls them waste.

A vast picture of this waste is given by Professor F. H. King in his classic, *Farmers of Forty Centuries*: 'On the basis of the data of Wolff, Kellner and Carpenter, or of Hall, the people of the United States and Europe are pouring into the sea, lakes or rivers, and into the underground waters, from 5,794,300 to 12,000,000 pounds of nitrogen, 1,881,900 to 4,151,000 pounds of potassium, and 777,200 to 3,057,600 pounds of phosphorus per million of adult population annually, and this waste we esteem one of the greatest achievements of our civilization.'

The loss of such quantities of the three elements is but a partial measure of the total loss, into the sea and other waters, of elements of the human life-cycle, a loss which could be avoided by the banking of these elements and returning them to the soil. To supply, by contrast, a picture of banking, Mr. King quotes Dr. Arthur Stanley, when Health Officer of the city of Shanghai, in his annual report of 1899: 'Regarding the bearing on the sanitation of Shanghai of the relationship between Eastern and Western hygiene, it may be said, that if prolonged national life is indicative of sound sanitation, the Chinese are a race worthy of study by all who concern themselves with Public Health. While the ultra-civilized Western elaborates destructors for burning garbage at a financial loss and turns sewage into the sea, the Chinaman uses both for manure. He wastes nothing while the sacred duty of agriculture is uppermost in his mind.' Banking for the soil, therefore, captures Dr. Stanley's decision. He was no advocate of sanitary progress for Shanghai in the form of destructors for garbage and the water-carriage system.

There are in Europe, however, towns which, like those of the Far East, bank in the interests of the soil. There are towns which have actually gone back to this banking after trying out the water-carriage system. The beautiful capital of Sweden is one, and its transfer back to use in place of wastage must have been just completed when the war broke out. In German towns banking was ordered by the Government in 1937, not as a part of the soil basis of civilization, but as a war measure amongst other war measures, an application of knowledge about life-creation to assist at life destruction.

In Britain, the Ministry of Agriculture in 1923 published a leaflet, No. 398, advocating this banking, but again not for the obvious reasons of the rule of return. Motor-cars, buses and lorries had greatly reduced the number of horses and the amount of stable manure. Among the various substitutes for this loss, one which had thereby gained a financial farming value, declared the department, was ashpit refuse. There was plenty of it, but it was unfortunately very little used. 'Incineration of this refuse is costly and is sheer waste. More up-to-date town authorities are now making an effort to dispose of their refuse in a better and more useful way, and some are adding other wastes and crushing the whole for use as a fertilizer.'

There follows an account of what some of these towns were doing: London, Glasgow, Dundee, Perth, Aberdeen, Rochdale, Warrington, Halifax and in particular Gateshead, where 80 per cent of the houses had 'mixed pail' or ash closets, and hence the 'home

refuse contains a considerable proportion of human excreta'. This was crushed with ordinary town and slaughter-house refuse, and made into a manure at the low price of two shillings and sixpence per ton, at which price it was eagerly bought by local farmers. Tested in the field, it showed itself a valuable substitute for farmyard manure. Night-soil in dried form was prepared and sold by the Rochdale, Warrington and other corporations, a method, which if generally adopted, said the leaflet, would solve the problem of the wastage of sewage and 'the shortage of organic manures on the farm would be greatly relieved; but we must expect these methods of conservancy to be superseded'. Fifty years ago even London was a town from which farmers could take night-soil for their fields. But the excessive convenience and niceness of the water-carriage system have given it the approval, not only of the urban peoples, but of many of the country folk also, so that now something surreptitious has become attached to any other method of disposal. One must expect these other forms of conservancy to supersede any form which recognizes sewage and garbage as merely latent forms of life. That, however, is unquestionably what they are; and a hygiene which destroys them and drives them out of the human life-cycle, has no real title to its name. In this it is the opposite of the name it bears.

The waste substances themselves show their avidity for life when put together. In the. making of manure from the various town wastes, the materials, when mixed together, cook themselves by fermentation. A heap of compost, for example, gets so hot that, if an iron rod is thrust into it, when withdrawn it is too hot to grip and hold. The final result of this cooking is like the leaf-mould that forms on the floor of a forest. The rotting of vegetable and animal matter in a forest is a cleanly process and that done in a town with town wastes can be as clean, and as free from flies and smell. It can, indeed, and should be the replica of the method of the forest, except that the pace of the urban method is rapid and makes good, sweet humus in three months, whereas the making of humus in the forest is a slower process. But in both cases there is evidence of active life. The heat is one evidence, and the growth of fungus is so active that it can be seen like smears of whitewash both on the floor of the forest and in the urban heap.

This waste then announces, in a really emphatic manner for something supposed to be dead and done for, that it is very much alive and that it is just as much a part of the life-cycle as a whole as it is when it pulses in the hot blood of a Derby winner. It is also hot life, indeed, for during the greater part of its activity it is considerably hotter than is an animal's blood. Then, when its heat and activity die down, it has become the pleasant-smelling and crumbling humus, which is a starting point of the rich green growth of healthy vegetation.

Such is one result of banks for the soil. The shamefully misnamed waste becomes the beautiful, soft, crumbling humus, which is the very substance of healthy life. It needs, perhaps, a poet to realize what beauty it contains. A poet can see in it the great, positive Yea, which is the unchangeable token of healthy life and of all that gives strength, grace, swiftness, endurance, cheerfulness, agility, elegance and beauty to mankind. It is the universal parent of the excellencies of life.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 9

Economics of the Soil

The link which connects towns and country in such a matter as the use of town waste is a money link, or cash nexus. Under present values one would be unable to find a municipality that turned its wastes into humus *for* the good of the soil, but only because, *as* good for the soil, the farmers bought it. By selling that which once had been waste, it is converted into cash, and this, in present values, is, the *good* result from the municipal point of view.

Leaflet No. 398, of course, had to accept the dominance of this way of valuing. It wished to persuade the farmers to make use of prepared waste, because thereby the great loss to the land of organic manure, which had resulted from the diminution of stable manure, would be mitigated, if not compensated. It was true that money, in the form of railway costs in particular, prevented farms distant from towns being able to get the manure, but those in their vicinity were urged to its use. As things were, the leaflet found that some 10,000,000 tons of ashpit refuse was produced annually in England and Wales, and that towns were spending £6,000,000 a year on collection and disposal. This was unquestionably waste.

The cash nexus, therefore, overrode more vital reasons. Twelve years after the issue of the leaflet of 1923, Sir George Stapledon gave out the ominous information that sixteen and a half million acres of England and Wales, or 43 per cent of the total of cultivable lands, had fallen into 'a more or less neglected condition'. They were, however, 'capable of radical improvement'. The Earl of Portsmouth, about the same time, summed up another aspect of the same question in these words: 'It is a staggering commentary on our present attitude to health and agriculture that, excluding all accident, all patent medicines and private medical cases, the bill for sickness in this country amounts to £276,000,000 a year, while the farmer receives for his gross output barely £250,000,00O.,

Putting the two together, there was a great deal of wastage of wastes and of land itself. The wastage of land was very great indeed and the more surprising in that it occurred in a country threatened by war on a greater scale than that recently experienced in 1914-18, in which it was nearly brought to its knees by the lack of well-cultivated homeland, a war in which also the blockade of its enemies and their consequent shortage of food was a large factor in their collapse. The need of good soil had been emphasized by world events in such high tones that it would be almost incredible that it was not regarded as a paramount national and popular need, were it not that, for a prolonged period, a thought-barrier had practically and intellectually shut out the people from the soil.

So one of the strangest things happened. In spite of the great danger of the neglect of soil being written large in letters of blood, the people were blind. They were also deaf, for they did not hearken to the warnings of such authorities as Sir George Stapledon, the Earl of Portsmouth, and many other leaders of the countryside. 'It takes two to speak the truth,' said Thoreau. 'One to speak and one to hear.' They were unable to hear.

The barrier was the paramountcy of money, of the cash nexus. As long as that was paramount, the creative power of life and all that pertained to it was inextricably fettered.

Only the rare man could himself escape from the entanglement and see things in their proper proportion. Such a rare man was the late Oswald Spengler, author of *The Decline of the West*, and his account is so clear that it must here be given in his own words. Spengler's German is very difficult. My quotations are from the two-volumed English translation of his work.

He begins his analysis at the time when civilization was purely agrarian. The life of the population is purely that of the peasant on the open land. The experience of the town has not yet come. All that elevates itself from amongst the villages, castles, palaces, monasteries, temple-closes, is not a city, but a *market*, a mere meeting place of yeomen's interests, which also acquired, and at once, a certain religious and political meaning, but certainly cannot be said to have any special life of its own. The inhabitants, even though they might be artisans or traders, would still *feel* as peasants, and even in one way or another work as such.

'That which separates out from a life in which everyone is alike producer and consumer is *goods*, and traffic in goods is the mark of all early intercourse, whether the object be brought from the far distance or merely shifted about within the limits of the village or even the farm. A piece of goods is that which adheres by some quiet threads of its essence to the life that has produced it or the life that uses it. A peasant drives "his" cow to market, a woman puts away "her" finery in the cupboard. We say a man is endowed with this world's "goods"; the word "*possession*" takes us back right into the plant-like origin of property, into which this particular being -- no other

-- has grown, from the roots up. Exchange in these periods is a process whereby goods pass from one circle of life into another. They are valued with reference to life, according to a sliding-scale of *felt* relation at the moment. There is neither a conception of value nor a kind or amount of goods that constitutes a general measure -- for gold and coins are goods too, whose rarity and indestructibility cause them to be highly prized.

'Into the rhythm and course of this barter the dealer comes only as an intervener. In the market the acquisitive and creative economics encounter one another, but even at places where fleets and caravans unload, trade only appears as an *organ* of countryside traffic. It is the "eternal" form of economy, and it is even to-day seen in the immemorially ancient figure of the pedlar of the country districts remote from towns, and in the out-of-the-way suburban lanes where small barter-circles form naturally, and in the private economy of savants, officials, and in general everyone not actively part of the daily economic life of the great city.

'With the soul of the town a quite other kind of life awakens. As soon as the market has become the town, it is no longer a question of mere centres for goods-streams traversing a purely peasant landscape, but of a second world within walls, for which the merely producing life "out there" is nothing but object and means, and out of which another stream begins to circle. The decisive point is this -- the true urban is not a producer in the prime terrene sense. He has not the inward linkage with the soil or with the goods that pass through his hands. He does not live with these, but looks at them from outside and appraises them in relation to his own life-upkeep.

'With this goods become wares, exchange turnover, *and in place of thinking in goods we have thinking in money*.

'With this a purely extensional something, a form of limit-defining, is abstracted from the visible objects of economics, just as mathematical thought abstracts something from the mechanistically conceived environment. Abstract money corresponds exactly to abstract number. Both are entirely inorganic. The economic picture is reduced exclusively to quantities, whereas the important point about "goods" had been their quality. For the early-period peasant "his" cow is, first of all, just what it is, a unit being, and only secondarily an object of exchange; but for the economic outlook of the true townsman the only thing that exists is an abstract money-value which at the moment happens to be in the shape of a cow that can always be transferred into that of, say, a bank-note. Even so the genuine engineer sees in a famous waterfall not a unique natural spectacle, but just a calculable quantum of unexploited energy.

'It is an error of all modern money-theories that they start from the value token or even the material of the payment-token, instead of from the form of economic thought. In reality money, like number or law, *is a category of thought*.'

Here is clarity joined with profundity, a feat only to be executed by genius. The initial picture of the agrarian world, in which production primarily from the soil, gives the products a reality because of the quality or life that is within them. They become man's possessions, something near him, placed or sitting by him, and valued with reference to life. But with the soul of the town a quite other kind of life arises, one in which something intervenes between 'goods' and man. The result, in its essence, is contained in the change from creative goods-thinking to abstracted money-thinking, expressed in phrases italicized by Spengler himself: 'With this goods become wares' (things of the warehouse not of the personal home), 'exchange turnover' (not as a mere inter-change of goods for other goods), '*and in place of thinking in goods we have thinking in money*', and 'in reality money, like number and law, *is a category of thought*'.

Let us look closely at this differentiation, particularly in its relation to those 'goods', which are most nearly related to life and without which life could not be, the food-products of the soil. The vegetable food-products are seeds, roots, leaves and fruits, and early men made the observation that when seeds were put in the ground, a plant grew up which produced a greater number of seeds than were put into the ground. These men did not worry about whether or not the production of a great number of seeds from a few revealed a rather gloomy and even brutal design on the part of nature to make the few seeds successful in becoming plants and so proving their superiority to the rest as the fittest to survive in a struggle for existence. They did not regard the few and the many as being due to a rather snobbish, if divine, order of precedence, serving as the explanation of the exuberance of the creative power. They were more simply bound to the facts that these extra seeds, tubers, fruits and foliage provided them with food, and they saw themselves dependent upon the manifold character of re-creation. All they understood was what they saw, namely, the generous outpouring of abundance, in response to their efforts, by a mystical power, which in its working was beyond them, but in its revelation to them aroused their awe, their reverence, their gratitude. So they served nature to the best of their ability, drew their share from the cornucopia of abundance and humbly thanked a God in this revelation of paternal love and superhuman magnanimity.

The abundance, as the result of their labours, enabled the work of a group of families to supply food not only for themselves, but for others. A certain part of their produce was, therefore, set aside for the non-working members of the families, for craftsmen who gave them possessions in return for food, and for the men of government in the form of taxes. So much of their produce had to go to government. They did not pay government for its services in money, but in produce.

Now the great significance of the tax in kind is that it is, of course, completely related to the basis of human life, the soil. The soil yields so much grain. The grain is mixed, spread out and a portion, say a fourth, is taken by an official for government. Taxation, therefore, receives the stability of the soil, and nothing really is so stable in human life as the well-cultivated soil. There is, when products are many in character,

a fairly steady average return in response to a traditional agriculture, if that agriculture is not wasteful. There *must* be some such steady relation of the soil to men, for human life to continue without violent fluctuations. There are, of course, good seasons and bad seasons. There are times of drought, there are times of flood, but a settled and capable form of agriculture does produce prolonged national life.

Payment of taxes in kind is a payment in terms of that which is primary to national life. It is factual and real in a whole national sense. It is terrenely genuine and sufficient, and has no foreign, extraneous and unlimited character, such as life dependent on conquests, on the wreck of weaker nations or, through the agency of money, on the well- or over-fed condition of the few and the underfed condition, or malnutrition, of the many. It, in fact, liberates the soil and keeps it free from money, the one real and essential freedom for a whole national life.

In the old conception the peasants paid the king for national protection. That was the service he rendered to them and for which they returned reciprocal service. That is the doctrine to be found in the classics of the past, such as the Smriti or law-books of ancient India. The land of the country was not the king's property, but *the common property of all who work on that land, and enjoy therefrom the fruits of their labour*, as Professor Dvijadas Datta insists in *Peasant-Proprietorship in India*, 1924. Taxes were to protect the living land and the land of the living, and not as they have now become, under the priority of money, for things so anomalous as, for example, the payment of interest on money lent by the privileged class for wars that were fought and decided over a century ago. The peasants did not pay the king to protect the land against enemies, whose dead bodies had for long been dissolved into soil-fertility. They paid for the protection of the land on which they were living and by which their nation was living.

No one can juggle with the soil as acquisitive men have learnt to juggle with money. The soil is reality; it has its own dominant character: it is more powerful than man, for it has that infinite mystery of power to turn death into life, and so not to remain as death. But money is purely man's invention and he can fashion it of what he likes, from the ponderous blocks of iron of the honest Lycurgus to the book-entries of modern bankers or manufacturers of credit. It can take every form of transubstantiation that dominant men choose to put upon it. It permeates everything that they dominate. It is only upon the land that men will ever be able to get free of it. It is only there that they will be able to see clearly what life really is.

And life is something that starts from the health of the soil in a way that, if it is to be successful, the principle of life must direct. Soil, in conservative and whole life, directs and rules money, not money the soil. Soil is the first primary thing and in reconstruction its needs must be provided for apart from the assumption of priority by money.

Money acts rather as a balance, as a subservant to the soil. So it acted at least amongst

Indian and other peasantries. That is why it was denoted by metal and why it was recognized as a possession because, being metal, *it had durability* as the land had durability. It could act as a substitute of the land. When there was scarcity in local soil-products, coins came into existence to make stored food and second-class food available by assisting poor land to be cultivated. When famine threatened or existed, then the silver bangles of Indian women were taken and handed to the *sowcar* and weighed by him and turned into an equivalent weight of silver coins. So coin became more plentiful at times of distress.

This is the *exact opposite* of urban banking. When distress threatens, bankers call in their loans. As distress increases, money in circulation becomes less, not more -- more distress less local money, not more distress more local money. In very great distress, according to the sages, it was right for the king not only to forgo the taxes in kind, but to give money, not loan it, in order to lighten the distress by enabling the suffering people to buy food and assistance from outside their locality.

The right economics of the soil do not exist under thinking in terms of money. If the soil is lined up with other productive agents of saleable goods, then its intrinsic character vanishes. It is essentially different to goods manufactured for sale, for it is as much property of life as is the air. Neither soil nor air have market value because they are necessary means of life. There is no market value yet for air, there should not be one for soil. City air, burdened with petrol, is not bad economics but bad life. The soil, that is burdened with money, is not bad economics, but bad life. That is why the right human partnership with the soil is an essential of human life, if it is to endure.

With the right conservation and service, the soil responds with something that is as certainly stable as the human virtue which, through the continuity of family service, provides this protection. It responds with its repetitive, but limited, gifts with a regularity, which is entirely different to the violent fluctuations in national and personal life which have occurred from the output of the precious metals, and owing to which the most profound effects in modern civilization have followed upon the discovery of Potosi silver, Californian gold and improved chemical processes for extracting gold. Nothing, one feels, could be more fantastic than to try to stabilize human life -- and it must be stabilized if catastrophe (or change in the crust of the earth which is one of its dictionary definitions) is to be avoided -- while measures of such inconstancy are permitted to dominate.

Let us now, then, in the midst of our inconstancies and the great catastrophes in which we have our present being, in this our reconstruction review this great virtue of *constancy* in terms of the creative power of the soil. Here we have for our enlightenment Professor F. H. King's book, *Farmers of Forty Centuries*.

His introduction of ten pages is one of contrast pictures of the thorough and profound relation of men to the soil in China and its pupillary countries, of the conditions of social constancy that result therefrom, and of the undeveloped relation to the soil of

men in the West. He took as a striking example the meticulous care with which water is preserved and used for the land in China. 'To anyone who studies the agricultural methods of the Far East in the field', he wrote, 'it is evident that these people, centuries ago, came to appreciate the value of water in crop production as no other nations have. They have adapted conditions to crops and crops to conditions to such a pitch that in rice they have produced a cereal which permits the most intense fertilization and at the same time ensures the maximum yields against both drought and flood. With the practice of Western nations in all humid climates, no matter how completely and highly we fertilize, in more years than not, yields are reduced by a deficiency or an excess of water.'

He went on to summarize the magnitude of the systems of canalization in China, a conservative estimate of which would place the miles of canals at 200,000. China has as many acres in rice each year as the United States has in wheat, yet the rice does not bear rice alone, but 'produces at least one and sometimes two other crops each year'.

When and where water is not available for irrigation, the people cultivate 'quick-maturing, drought-resisting millets as the great staple food crops', and for them the water is preserved by 'almost universal planting in hills or drills, and so making possible the utilization of earth mulches in conserving soil moisture'. Thus 'these people have with rare wisdom combined both irrigation and dry farming methods to an extent and with an intensity far beyond anything our people have ever dreamed of, in order that they might maintain these dense populations'.

The canals, moreover, render not only water, but a refreshment of soil itself comparable to that of the overflow of the Nile or of the warping of the Isle of Axholme. 'In China enormous quantities of canal mud are applied to the fields, sometimes at the rate of even seventy or more tons per acre.' And where this mud is not available, they yet refresh the soil in a manner again rivalling the autochthonous renewal of Egypt. 'So, too, where there are no canals, both soil and subsoil are carried into villages and there they are, at the expense of great labour, composted with organic refuse, then dried and pulverized, and finally carried back to the fields to be used as home-made fertilizers.'

Finally, on page 241, he asserted that 'China, Korea and Japan long ago struck the keynote of permanent agriculture ... In selecting rice as their staple crop; in developing and maintaining their systems of combined irrigation and drainage, notwithstanding that they have a large summer rainfall; in their systems of multiple cropping; in their extensive and persistent use of legumes; in their rotations for green manure to maintain the humus of their soils and for composting; and in the almost religious fidelity with which they have returned to their fields. every form of waste which can replace plant food removed by the crops, these nations have demonstrated a grasp of essentials and of fundamental principles which may well cause Western nations to pause and reflect.'

Without much reflection, it must be quite clear that in these works and actions of the

Chinese, all the factors which promote the fertility of the soil are brought together so as to ensure and preserve its highest creative power. This is done 'at the expense of great labour' as the true character of the economics of the soil. By such great labour a fair constancy of return from the soil can be assured, a constancy which has no parallel in the dominant money system of our time, a constancy which depends upon the fact that if all the factors of fertility in a locality are brought into the action of cultivation, the results will reach a certain degree which they cannot surpass.

The whole conception of dominant money is, on the other hand, foreign to the soil. When money is lent, it expects to get not itself but more than itself in return. Omitting the speculative hopes of capital improvement, money lent expects an addition of itself called interest.

But in good agriculture, fertility is fully used in producing a crop. It is not and cannot be called upon to create an extra quantity of itself so as to produce an extra crop or interest. Only something parasitical could add itself as an *extra growth on decadent vitality* and that does not occur in whole farming. In farming dominated by money, however, parasitism is as abundant as debt, like breeding like. If one reads a book on modern farming one cannot help being struck by the number of parasites that take their share in it. There are warble flies, scabs, lice, fleas, maggot flies, bollworms, eelworms, wireworms, fruit flies, fungi, leaf roll, blackscab, blight, mosaic, rust, bunt, smut, leaf stripe, black leg and so on. The more complex scientific farming becomes says Mr. D. H. Robinson, the greater 'the spread of complaints which formerly were unknown or of little importance'.

There is clearly quite a definite difference between a farm carried on for the preservation of a high fertility and one for the immediate production of money-crops, enforced to this by the dominance of money and credit-debt. Once a farm is involved in the credit-debt dominance, once this credit-debt is looked upon as a first need or chief claimant, then agriculture becomes inextricably involved in a huge system, with its owners and managers, and its local, national and international debts. These debts affect everyone within the system. Modern men, therefore, in facing the problem of life, find themselves loaded and hampered by the dead weight of debt. The size and pace of enhancement of these debts are so extreme that there is no hope of their being balanced by the creative power of life. The only reply to them is to use up without replacement the stored fertility of the past. Even this fails. It does not abolish, but extends debts and debtors on the land. The whole position is so utterly beyond any balance that only men with minds split from the reality of creative life could possibly acquiesce in the hypotheses and creeds which have arisen to fortify it and to make it appear rational and sane, hypotheses which were eventually forced to raise the sleek speculator and the barrel-bellied millionaire to the status of darlings of nature; her selections in the survival of the fittest!

The stark fact that appears now, and which wrote itself across the Roman Empire, is that debt and taxation increase as the soil declines. The one is a counterpart of the

other. The huge, unpayable debts are the measures of the death of reality; step by step they are matched by the loss of soil-fertility. In coming chapters we shall see how remarkably the greater money dominance of the present era is matched by the greater ill of the soil. The money dominance and its vast debts, personal, local, national and international, are on the side of death and against the creative power of life.

Nature, it must be remembered, has no interest in maintaining a more highly organized form of life such as man is. If he takes a harmonious place in a life-cycle, he will continue; if not, he will be replaced by some other form of organic life, as bracken replaces grass. Survival is not a matter of struggling to be fittest, it is not a matter of the modern boast of the conquest and exploitation of nature. *It is a matter of reverence*.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 10

The English Peasant and Agricultural Labourer

The English peasant first appears in Engleland as an individual with a strong bent for independence. Engleland was the southern part of the thumb of land that projects itself between the North and the Baltic Seas, the northern part being the land of the Jutes or Jutland.

The dwellers in Engleland, writes Mr. John Richard Green, in his Short History of the English People, 'seem to have been merely an out-lying fragment of what was the Engle or English folk, the bulk of whom lay probably along the middle Elbe and on the Weser', and he adds that they were allied to peoples occupying a wide tract reaching to the Rhine and collectively known as Saxons.

Mr. Green does not, however, speak of the fascinating theory of Henri de Tourville, who gives the name of 'particularist' to these Nordic peoples, because they were people of the small or particularist families of husband, wife, and children as opposed to the large joint families of fathers, their sons and grandsons and their wives and children. Henri de Tourville, in his *Histoire de la Formation Particulariste*, believes this small family came into being in the following way: some Teutonic or Nordic people reached the plains of Sweden and in their search for undisturbed homes, passed on over the mountains and settled along the fiords of Norway.

Anyone who has voyaged up these fiords must have been struck by the patches of bright green cultivation that are set between the precipitous mountains and the sea water of the fiords. They are like unequally spaced gems of emerald. He will also have been struck by the smallness of the greater number of them. Nevertheless, what is grown on them and the fish of the fiords still form the food of isolated families.

These families were small or particularist owing to the sheer limitation of vegetable food. When the families of a fiord grew too large, the younger members gathered together, stocked a few ships and voyaged southwards, seeking land for themselves in fiords farther south, in the projecting thumb of Denmark, in the northwestern river-lands of Germany, and finally in the island of Britain. In the new settlements, the love of independence led to the persistence of the small family system.

However this system actually arose, it has been of great significance in the world's history. It is the oddity as opposed to the customary large or joint family; it is independent individuality as opposed to dependence on joint opinion; and a very strong oddity it has proved to be. However rude and rough these early Engles may have been, there are few Englishmen now who will not be thrilled, when they read how Tacitus, coming from the great city-world of Rome, was struck by the jealous independence of each farmer and his family in their settlements. 'They live apart,' he wrote, 'each by himself, as woodside, plain or fresh spring attracts him.'

They could not, however, be quite independent. Dangers from other peoples sometimes threatened them and they then joined together, chose a chief and took to arms. They were fierce fighters and, when they arrived in Britain under their captains, they drove the Britons westwards or slew them, and took their land, until once more they were independent farmers at peace. They were the forerunners of similar settlers in America, Australia and New Zealand.

But, before the coming of the Norman Conqueror, these farmers, says Green, lost most of their peace and much of their independence. They had so many wars that warrior-kings and their military subordinates had become a standing feature of their society. For greater protection against invaders, like themselves in race, they had to submit to larger associations, and eventually one kingdom. They lost their spontaneity of action and had, as a condition of existence, to attach themselves to a lord or thegn of the King's party. 'The ravages of the long insecurity of the Danish wars aided to drive the free farmer to seek protection from the thegn,' wrote Green. 'His freehold was surrendered to be received back as a fief, laden with service to its lord. Gradually the "lordless man" became a sort of outlaw in the realm. The free churl sank into the villein, and changed from the freeholder who knew no superior but God and the law, to the tenant bound to do service to his lord, to follow him in the field, to look to his court for justice and render days of service in his demesne.'

The coming of the Conqueror, William of Normandy, increased and confirmed the subordinate position of the English farmers, by giving them foreign conquerors as their lords. The tendency to the establishment of the authority of the aristocrat 'was quickened by the conquest', wrote Green; 'the desperate and universal resistance of his English subjects forced William to hold by the sword what the sword had won, and an army strong enough to crush at any moment a national revolt was necessary for the preservation of his throne. Such an army could only be maintained by a vast confiscation of the soil. The failure of the English risings cleared the way for its establishment; the greater part of the higher nobility fell in battle or fled into exile,

while the lower thegnhood either forfeited the whole of their lands or redeemed a portion of them by the surrender of the rest.' Land became the property of the King, who rewarded his followers and bound them in their interests to his, by gifts of land as private property. The Norman aristocracy received many estates, scattered so that they could not constitute a dangerously strong local power, but even 'the meanest Norman rose to wealth and power in the new dominion of his lord'.

So William initiated land as the private property of an aristocratic caste of landowners, and the peasants became bound to the land as serfs.

England was, humanly speaking, a very small country at that time. The population was some two million at the time of the Conqueror and two and a half million at the time of Edward III. The total area of cultivated soil was small, the greater part of the land being forest and therefore possessing undisturbed its primal vegetative cover. The farming was backward as the slow growth of the population reveals, and, compared to that of more enterprising countries on the Continent, it remained backward for many centuries. Nevertheless, it produced a life-cycle which, though of low grade, preserved within itself a certain stability and was free from pronounced waste.

When a balance between the English and their Norman conquerors was brought about by time, the features of an association based upon the soil, with which readers are now largely acquainted, came into being. The farming was carried out by a method of large estates. These estates were called manors and the heads of the estates were the lords of the manor. Under them the people worked, with various grades of right to the land, by which one and all got their food and home directly from the land. The country as a whole was in a condition of 'Natural Economy', not 'Money Economy', and such commonplaces of the country of to-day as are capital, labour, competition, employee, had no meaning. The family or associative method was everywhere. A man might employ labour, but he worked himself with those he employed and he ate the same foods as they did. The manor was, indeed, like a large family. It was a self-contained community and the land itself was the father and mother of the community. The lord of the manor represented a personal government, but he was not able then to do with the land what he wished. His position was that of chief functionary, and not that of slave-owner as in post-Punic Italy.

The land was worked on a common plan. There were no separate fields, but one large open space marked off into strips by balks. The lord of the manor would often have his strips amongst those of the villagers. In such cases the community was a true community, in which the land was alike to all. But in other cases the personal land of the lord of the manor was not amongst but separated from that of the villagers. The community was then almost, but not quite, a true community based upon the soil.

In addition to farming by the manor system, the most or only educated section of the people, the monks of the Church, contributed to the national farming the benefits of their devotion, learning and art.

William Cobbett has given an account of the special character and quality of the monasteries and their meaning in an agricultural civilization, in *The History of the Protestant Reformation*, written over a hundred years ago. He said: 'Nor must we by any means overlook the effects of these institutions on the mere face of the country. That man must be low and mean of soul who is insensible to all feeling of pride in the noble edifices of his country. The monastics built as well as wrote for posterity. The never-dying nature of their institutions set aside in all their undertakings every calculation as to time and age. Whether they built or planted, they set the generous example of providing for the pleasure, the honour, the wealth and the greatness of generations upon generations unborn. They executed everything in the very best manner: their gardens, fishponds, farms, were as near perfection as they could make them; in the whole of their economy they set an example tending to make the country beautiful, to make it an object of pride with the people, and to make the nation truly and permanently great. Go into any county and survey, even at this day, the ruins of its, perhaps, twenty abbeys and priories and then ask yourself, "What have we in exchange for these?"'

To their practical farming, the monks brought the help of the classic writers of Rome, of Cato, Varro, Columella and others, whose works in Latin they were able to read. They were *cultured* farmers, to whom the spiritual side of creation appealed with especial significance. It was they who instituted improvements and preserved a standard in medieval farming. It was they who harboured that endeavour to do well, without which the work of the mass of men tends to decline. It was they who built roads and bridges, and maintained traffic by opening their monasteries as places of temporary rest and hospitality to all travellers, rich or poor; they who drained marshes, reclaimed wastes, and improved livestock. It was they who filled in what one might call the full composition of a soil-based civilization by giving it the vision of religion, the art of the temple, and the culture of studentship. They also defended, as far as they could, the independence of the peasants, and supported them in their efforts to rise out of serfdom.

The lords of the manor were the worldly heads of the people. They supervised and directed the division of the land, saw to the upkeep of cottages and buildings, presided over schooling and apprenticeship, arranged marriages, punished slovenly work, dealt with quarrels and crimes, checked short weights and the adulteration of grain and beer, arranged for the exchange of goods, and directed the relations of the villagers with the outer world which began on the farther side of the forest that bounded the manor.

We now come to the introduction of 'Money Economy' to the land.

At the time when the manor system flourished best, the lords of the manor were the paternal chiefs of the villagers. But they also had a number of rights which belonged to a conquest and were, in fact, derived from the Norman Conquest. It was these

rights that made their precedence in the village something different from that of the village assembly, which is the common form of village rule and which constitutes the true freedom and independence of the partners of the soil. The lords of the manor had the right to exact a varying amount of enforced work from the villagers; they exacted fees for the services of the manorial court; they had the right to sell timber from the estate, to permit strangers to take up land, to mill and even bake the people's bread; and, their class being the lawmakers of the country, they were able to pass such laws as the Statute of Merton in A.D. 1236, which gave them a right to enclose certain lands of the villagers for their own use. In brief, they were indisputable masters; they prolonged the Conquest indefinitely and thereby prevented the villagers of England from getting complete freedom of property in the land they cultivated.

There was one other privilege of the lords of the manor which was a direct contradiction of the freedom of the soil to terrene man. It was this. They had the right to fold, not only their own cattle, but also those of the villagers, on their land. They became the manurial, as well as the manorial lords of the estates, and everyone in the village, of course, knew that their lords robbed them of food, when they took the manure.

The lords of the manor, judged from the basis of the soil, became thereby *life-robbers in the midst of the village*. They were manurial robbers long before they became open robbers and pillagers under Henry VIII. By their theft or privilege, whichever it be called, their land received a greater and the villagers a less fertility and, *in accordance with this change in the soil, there came into being a change in the human beings*. A difference in quality entered. The rich, fed by a more fertile soil, were better in physical quality. The level of the people generally was degraded. Rich and poor became not only a thing of measurement by money, but a visible physical condition.

There is nothing perhaps that has to be made more clear than this: that the first separation leading to the divided classes of employers and employed, of rich and poor, with the poor dependent not on the soil but on the rich, was a separation of farm dung. It was a personal sequestration of life-elements. It was not a crime in English law, but in terms of the soil, a lethal type of crime eventually to lead to disasters for the robbed. Immediately, owing to it, the life-cycle of the lord's demesne was improved, that of the peasants' land was diminished. 'On land which was inadequately manured,' wrote the late Lord Ernle, in *English Farming, Past and Present*, 1922, 'and on which neither field-turnips nor clovers were known till centuries later, there was no middle course between the exhaustion of continuous cropping and the rest-cure of barrenness.' Much of the land had to lie fallow, unused and uncultivated until it recovered its strength, a natural part of which the lords of the manor had taken from it. The aristocracy needed the extra wealth which this sequestration of life-elements brought them. The crime was forced upon them by their luxury and expenses as courtiers and as warriors in the Crusades and French wars. They became, consequently, exactors, not protectors, of the soil, and they displaced the old Natural Economy of the manor for the new Money Economy.

The more enterprising and frugal villeins of the manor, supported by the Church, saw in this need of their lords the opportunity to satisfy their cravings for independence. With the surplus they achieved by their ability, they won their freedom from service to their lords and they became tenants by the payment of rent. They took over land, too, from the least efficient of the manor's farmers and worked it with the previous owners as labourers, thereby becoming in the manor the *Kulaks in the Mir*, to speak in Russian terms.

Thus, during the slow break-up of the manor system owing to the introduction of the new Money Economy, the people of the manor came to be divided into four classes; the first was the lords and their families and personal dependants; the second the tenant farmers; the third the villeins, who did not become tenants; and the fourth those who failed to support themselves upon the land that had been allotted to them, and who now worked for their more successful brethren for a wage paid in kind or in money. This fourth class are often spoken of as the class of *free labourers*, because they were to some extent free to sell their labour. Their freedom was very limited, being due to their poverty, which compelled them to use it, as labour uses its freedom to-day, in binding itself to this or that master. They lost their right to the land and to the stock which had been their capital. Their value was relative to their abundance or their shortage. Only when there was a great shortage of labour, such as that which followed for many scores of years the destructive Black Death of the middle of the fourteenth century, did their wages exceed the cost of their necessities. Thorold Rogers called the fifteenth century the golden age of the English labourers or farm-workers measured by the relation of their wages to the prices of their necessities.

The freedom that these relatively high wages brought was defeated by the continuous decline of the soil of the land in the early Tudor period. Lord Ernle wrote: 'Land had depreciated in value; rents had declined; farming had deteriorated; useful practices had discontinued; cattle were dwindling in size and weight; the common pastures had become infected with "murrain"; the arable area of open fields had grown less productive, and without manure its fertility could not be restored.'

Desperate measures were required to save the land and the measures undertaken were those dictated by the ascendant Money Economy. In Roman Italy, after the Punic Wars, the deterioration in fertility of the soil led to the substitution of family-owned farming by large estates, the *latifundia*, and large landowners. In Tudor England the same substitution of *latifundia* for small family farming also took place. In post-Punic Italy, acquisitive men seized the lands of weakened farmers with complete disregard of the law. 'The whole system', Mommsen tells us, 'was pervaded by the utterly unscrupulous spirit characteristic of the power of capital. ... Roman capital was gradually absorbing the intermediate and small landed estates in Italy as well as in the provinces, as the sun absorbs drops of rain.' In Italy, the large number of slaves acquired by Rome's conquests, hastened the process, for it was easy for large landowners to break right away from their own fellow- countrymen, and, leaving

them to their fate, to engage foreign slaves for the service of the Italian soil. In England the process of the eviction of peasant family farming was not completed until the industrial era itself.

In both cases, as on similar occasions elsewhere in history, the social change was in the nature of a conquest. A group of acquisitive men, who had got money by other ways than those of direct agriculture, acted as conquerors. They overthrew the peasants' customary rights in the soil as the basis of the State and made land a commodity to be purchased by the richest bidder. In Italy these acquisitive men were the Equites or Knights, who had acquired great wealth by acting as middlemen in the newly acquired realm of Rome, and who were to form the chief part of the aristocracy of the eventual empire. In England the acquisitive men, who overthrew the agricultural basis of the State and with it the Church and the monks, became the new aristocracy of Tudor England. In both cases also there were statesmen and other leading men, who set themselves against the 'terrible measures' under which the independence and rights of the farmers and of the free labourers were to succumb. Such were Wolsey, More, Latimer, and Queen Elizabeth and her Ministers amongst the English. Nevertheless, in spite of all such efforts the great living fact about a soil remained and that fact was expressed by Ernle in the words: 'Without manure its fertility could not be restored.' Dung had to save the soil, and the quickest way to dung the land was to enclose it with hedges and breed and put upon the fields sheep and cattle. Fortunately, the acquisitive men were attracted to this method by the price that British wool fetched upon the Continent. It was this opportunity for more wealth that made them seize the land of the small men and of the monasteries and with the expenditure of their capital turn it into sheep farms. It was unquestionably good for the soil, but it entailed a brutal punishment to the small farmers, and farm labourers, whose only sin had been that they had submitted originally to the enclosing of the lord's demesne upon the manor and the robbery of the dung of their animals for the land of the manor's lord. So, a new aristocracy arose upon the human relics of a system that had failed and the brilliant later Tudor period of English history followed.

From that time the proletariat and pauperism became the familiars of social England. No appreciation of the value of the small holdings appeared. There was no Prince Kropotkin at that time to make what would have seemed an insanely preposterous statement that, with the intensive farming of small holders, the British soil might support a hundred million inhabitants. Nothing was known of the rich results of the Chinese peasants, who were so skilled in the use of water and who followed the rule of return with such meticulous care. Nothing was known of the agriculture of the fallen Arabic Empire. The Tudor world was deeply stirred by what Green calls the New Learning, but the New Learning did not bend down to the humble giver of life, the soil.

For the further story of the English agricultural labourer, the -only authoritative history in English that I have been able to find is *A History of the English Agricultural Labourer*, by Dr. W. Hasbach of the University of Kiel. It was first published in 1894,

translated into English in 1908 and reprinted in 1920.

Where enclosure occurred, Hasbach says, a proletarian class appeared. English agriculture from the fifteenth century, when rich commercial men began to buy out owners living on their land, was 'sacrificed to the interests of industry'.

He gives a full account of the second great period of enclosures, that of the eighteenth century. It was in the latter part of this century that the genius of the English and Scotch brought in a new epoch, that of the machine. The power of the machines effected a revolution. Manufacturing towns grew up and multiplied, and the demand for food put a premium on the land. The Tudor enclosures had only affected a limited area, but now there was a far greater cry for new and undeveloped land and for the deteriorated land, on which the poor crops and poorer cattle revealed the need for capital and manure. In the pre-machine part of the eighteenth century, Enclosure Acts were few; in Anne's reign two, in George I sixteen, in George II two hundred and twenty, but in the latter part of the century, when George III reigned, there were three thousand five hundred and fifty-four. In the fifty years before George III 337,876 acres were enclosed; at the end of his reign 5,686,000 acres had been enclosed.

As in the times of the Tudor, there was a great improvement of the soil enclosed. Robert Bakewell (1725-95) transformed raw-boned cattle and lean sheep into animals twice the size; from 1776 on, Thomas Coke of Norfolk proved the capacity of capitalistic mixed farming to carry treble the livestock and to produce rich crops of wheat in place of scanty rye. Turnips were grown for winter feed of the cattle and clover for the improved feeding of the soil. Earnest farmers followed these great examples. Nevertheless, the main impulse to the enforcement of enclosures was the opportunity of acquisitive men to rise quickly to great wealth. It was this that gave the movement its brutality and the character of a civil war between one section of the people and another. Though the swords of the fortune hunters were sheathed in legality, they were none the less keen when unsheathed and so, says Hasbach, enclosures were 'not seldom changed into a national curse'. It was the better class of inhabitants of rural areas who appreciated local opportunities of seizure, and it was therefore 'squires, parsons and lawyers who were the chief owners and benefiters'.

Though peasant-ownership-farming survived in some few parts of England, in general 'yeomen farmers and peasant proprietors ceased to exist; they drifted to the towns and sank into workers at a daily wage. Not only small holdings but the lesser tenancies gradually vanished in a universal system of large estates and farms.' This quotation is from Richard Green.

The agricultural labourers in this period reached the nadir of their fate. They had no protection from the Church and the monasteries, as they had when Catholicism was the religion of England; their cottage industries had been supplanted by the new machines of the towns; the days of an agricultural labourer trades union were yet to come. They were utterly helpless and hopeless. They were not even slaves, ensured by their masters as regards board and bed. The landowners ceased to pay wages in

kind, in other words in food, because food fetched higher prices in the towns and the yeomen who had once filled the village markets, were no more. Their food was almost confined to wheaten bread, which, being wholemeal, supported life. Their wages were miserably small, so small that the parishes often had to add to its pittance an allowance from the rates. Because of this the parish authorities hired out the labourers, and sometimes, says Ernle, 'the paupers were paraded by the overseers on a Monday morning, and the week's labour of each individual was offered at auction to the highest bidder'.

The labourers presented heart-rending pictures to their bravest champion, William Cobbett. Here is one taken from his *Rural Rides* in 1821. 'The labourers are miserably poor. Their dwellings are little better than pig-beds, and their looks indicate that their food is not nearly equal to that of a pig ... The land all along here is good. Fine fields and pastures all around; and yet the cultivators of these fields are so miserable ... When I see their poor faces present as nothing but skin and bone, while they are toiling to get the wheat and the meat ready to be carried away to be devoured by the tax-eaters; I am ashamed to look at these poor souls and to reflect that they are my countrymen, and particularly to reflect that we are descended from those amongst whom beef, mutton, pork and veal were the food of the poorer sort of people.'

This degradation of labourers on the land was essentially English. It did not happen in England's neighbour, the Netherlands. Nathaniel Kent travelled in the Netherlands, and, in his *Hints to Gentlemen of Landed Property*, A.D. 1775, tried to awaken the said gentlemen to this fact. In the Netherlands, he wrote, there was an astonishing quantity of provisions, and as one of his broad hints to the Gentlemen of Property, he recorded that *the holdings were all small and the cultivators on equality*. This degradation, therefore, only happened in England. And even then, strangely enough, it was not inevitable everywhere in England itself. That indefatigable traveller on behalf of agriculture, Arthur Young, at one time the zealous champion of Enclosures, but later of the opposite opinion, discovered 'with great delight the life of the small proprietors of Axholme' (*Report on the Agriculture of Lincoln*, A.D. 1799)

Now the singular fact about these small proprietors of the Isle of Axholme was that they were *not English but Dutch. They were a bit of the Netherlands transplanted to England*. Their ancestors had been transplanted in the Isle of Axholme more than a century before Young visited them. The Isle was a swampy property of 46,000 acres between three rivers in Lincolnshire, and had the good fortune of belonging to one of the most cultured and educated men of his time in England, Charles I. Charles had knowledge of the small holders of the Netherlands, and he called some of their families over to England to drain the Isle of Axholme and cultivate it. They were true intensive peasant-family farmers, who, as Hasbach wrote, took every small advantage, cultivated every corner, had the help of their wives, brought up their sons in their footsteps, and 'serve the land in the way it should be served, never stinting themselves and as absorbed in their service as any priest in his religion'. So these peasant-families caused Axholme to flourish, and it was flourishing when it delighted

the eyes of Arthur Young at the time of the degradation of the small English proprietors and their expulsion by the Enclosures.

Axholme is still flourishing. Sir Rider Haggard in his *Rural England*, 1906, welcomed its 'almost inexhaustible richness ... it will produce magnificent crops of wheat, potatoes, celery, or whatever it may be desired to grow'. Mr. Gilbert Slater, yet later, in the *Making of Modern England*, 1934, seeing heavier crops in the Isle than he ever saw elsewhere, drew the conclusion that the men of the Isle of Axholme had abundantly justified their stout refusal to submit to enclosure in the eighteenth century. 'Not only are the open fields of the Isle of Axholme exceptionally well cultivated at the present time, but the island serves as a training ground in practical and effective farming, and men who begin as labourers there frequently become large farmers elsewhere.'

These skilled, independent men met with strong resistance from the English farmers who tried to expel them, but they inherited a tradition of soil-protection and feeding, which gave them great faith in their own work. They knew its superiority and they have not changed. Their ancestry 'affects the physical appearance and accent of the inhabitants of the present day' (*Encyclopaedia Britannica*, 14th edition).

The English labourers, in the early part of the nineteenth century, on the other hand, had lost all courage. They were an unprotected proletariat. In the times of their prosperity and independence, says Hasbach, 'they had avoided early marriages and abstained from multiplying as a mere proletariat does; whereas now all such evils appeared'. This, he goes on to say, with great significance to all narrow-visioned reformers who wish to increase a population, this is the answer to Malthus, who failed to recognize the psychological elements (despair of the future and of freedom) in the rapid increase of population. 'The error was immense.'

Hasbach places the beginning of the slight recovery of the English agricultural labourer at 1834, in which year a Poor Law stopped the parish allowance to advantage the farmers and made them, the farmers, pay the whole of the labourer's wage. Actual paupers were put in the workhouse. But the real betterment, he found, was in two things, allotments and trade unions.

About this time certain kindly farmers gave allotments of land to their labourers for their own use and were glad to find that, instead of making them work worse on the farmers' lands, they worked better. The eternal truth that everyone likes to be able to pride himself on his own work glimmered into being again and, from being proud of the crops they raised on their own land, these humble men and their wives and children took pride in the crops they raised on their masters' land. They did so well on their private land that when a Government Report in 1843 pressed for the extension of allotments by law, the farmers complained that they had difficulty in getting enough cheap manure as the labourers wanted it for themselves. The labourers in a very small way were, in fact, turning the scales against the old lords of the manor who had

started their troubles by stealing their soil-food.

In 1872 the labourers, under Joseph Arch, started a trade union, and 'considering the character of the labourers and their natural isolation they were at first very successful'. But their efforts to get better wages were defeated by the farmers, who summoned unemployed workers from the towns and impoverished Irishmen for harvesting, hop-picking and other unskilled work in the busy seasons.

'After a long period of depression the unions sprang into life again in the year 1890.' We find them going to the root of the matter in their attempts to free land from the dominance of money. They supported the Land Restoration League, which wished to put a tax upon rent and increase it progressively until it absorbed and eventually abolished rent, and thus achieve the aim of Henry George. Agricultural and urban unions began to work together to prevent town labourers frustrating rural strikes and vice versa. Though poverty, ignorance and isolation of their members kept the rural unions back, they always 'gave expression to the labourers' desire for land'.

Allotments remained the most recognized form of relief. In 1889 a Parliamentary Committee on Small Holdings, with Joe Chamberlain as Chairman, reported, with 'farsightedness and objectivity', that a well-to-do peasantry was beneficial to any country, nationally, socially, and economically, and this was supported by the Central Chamber of Agriculture maintaining that, whereas large farming was suitable to sheep and corn, small holders were suitable to other types of farming.

'The theory that the agricultural population in general was unconquerably attracted by the towns cannot be seriously maintained.' 'The labourers did not depart where allotments could be obtained, where good houses could be had at a fair price,' and where some independence thereby was theirs. They preferred to live in villages to having cottages on farms. Yet, with the village life, the younger generation began to show themselves discontented. 'The old semi-feudal relationships of the English village were no longer quite pleasing to the younger generation,' who were more willing to migrate to towns, chiefly, or even solely, because on the land there was so little chance to raise themselves socially.

Hasbach ends with a review of the labourer from 1894-1906, and in these last pages the light of hope is dulled. The prospects of betterment did not mature. The generation that was content with allotments, good wages and decent cottages almost died out. The new generation 'altogether despises the position of an agricultural labourer'. 'He is at the bottom of the social scale,' and knows it; whereas in a town a man can lose identity among the masses of the inhabitants'.

As a result of his study, Hasbach came to the belief that little or no permanent betterment in the lot of the labourer had been attained. He could not avoid the impression 'that, in spite of the talk of better wages, the lot of the agricultural labourer in many parts of the midlands, south, south-east and south-west, where often the houses are wretched and both allotments and small holdings are wanting, is such that

he is strongly induced to turn his back on the land, even though his sense of self-respect is comparatively undeveloped'. While the labourer strives for a humble independence, it is definitely the end of many people 'to place a proletarian class at the disposal of the farmer, believing such a step was in the interest of the employers'. No statesman had arisen capable of viewing the picture as a whole or of 'estimating the total probable result of any measure'. 'Hitherto failure has attended all attempts to apply to the problems of agricultural labour the principles which have been effective in the realm of industrial labour.' The consequence has been the demoralization and depopulation of the countryside. Facts show that the system of the large farm cannot meet the crisis. Hasbach's final advice is the greatest possible extension of small and middling holdings.

So ends this most instructive and unique book.

Between 1906, when Hasbach ended his story, and the present day, England has fought in two Great Wars; in both her people have been aroused to the perilous state of their food supply; in both they might and almost certainly would have been starved into submission, had it not been for supplies sent to them by the people of the U.S.A. In the first war there was a wise increase of allotments to increase food. Powers were given to local authorities to acquire land by compulsion for allotments, and their number leaped from 130,536 acres to 1,330,000 acres. In the interval of peace that followed, much land went out of cultivation. The great efforts to increase the production of food before and during the second Great War are too well known to be recounted here. How far we are from the knowledge of how to feed our soil, and how it can best be cultivated, these two great crises have revealed. In no country is a reconstruction by way of the soil more needed than in our island. We have a large population; we need a large fertility of the soil to render our population safe and healthy. We need to free ourselves from robbery of the soil.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 11

Primitive Farmers

The word primitive is defined by *Annandale's Concise Dictionary* as 'characterized by the simplicity of the old times'. The lexicographer, with this definition, hits off with happy ease an exact description of the primitive peoples of this chapter and of the two that follow it. 'The simplicity of old times' just fits, for the lexicographer informs us under the word 'simple' that it derives 'from a root meaning one or unity'. We can now paraphrase our heading of Primitive Farmers, as Farmers characterized by unity. We must do this quickly before going on to read other definitions of 'simple', for we shall find that one of them is 'easily intelligible', and farmers characterized by unity are not a bit easily understood by modern peoples. It is because they have so rarely been understood that so many troubles have come to them from the moderns.

The primitive people here to be considered are the Kikuyu of East Africa, for about these same Kikuyu a very rare kind of book has been written. Its authoress, in the beautiful phrase of Robert Louis Stevenson, eavesdrops at the door of the hearts of the people she describes. She is Mrs. Elspeth Huxley; her book, *The Red Strangers*. She tells her story from the mind and heart of the Kikuyu, to whom the British were the Red Strangers.

Before the coming of the British, the Kikuyu were a family of people, who cultivated the land by family ownership. The land was cleared from forest and cultivated. When its fertility was exhausted, a new clearing was made, and the old one allowed a long rest and return to jungly conditions for its recovery. This farming is known as that of shifting cultivation.

The Kikuyu grew fruits, beans, peas, millets, sweet potatoes and other food crops. They kept goats and cattle. The fields were worked by the women; the men protected the fields against the inroads of wild animals, tended and protected their domestic animals, acted as warriors when young and as councillors when old. They fitted their

life-cycle into conditions, which they modified to their own advantage, but to which they did no permanent destructive harm.

An important feature of the tribe in regard to its eventual meeting with Western civilization, was that it had no metal money. Nor did it have any other form of durable money. Its currency was formed by domestic animals; the smaller currency being provided by goats, the larger by cows. In this matter of currency, therefore, they reached back to that of the early ancestors of Western civilization, whose word for money, pecunia, was derived from pecu, cattle. This character is very useful to our contrast picture. In looking at the rather hearty and cheerful Kikuyu, as they first showed themselves, Westerners saw a people who still possessed characteristics of the original Latins, from whom their own civilization itself had derived. They thus looked over a Great Rift Valley of time.

Goats, then, were the pecuniary units of the Kikuyu. A poor man had a few goats, a little land and one wife; a rich man many goats and fields, together with more than one wife to work the larger possession and more sons to tend the more numerous animals. Cows also were symbols of wealth. A cow was valued at about a dozen goats. If a man procured the consent of a maid to marriage, he had to pay some such sum as thirty-five goats, or two cows and ten goats to her father, and sometimes rams and brews of beer made a part of the payment. A field was valued at so many goats. A crime was expiated in a payment of goats to the injured party, or, in the case of murder, a fine of over one hundred goats paid by the clan of the slayer to the clan of the slain.

Goats possessed a second quality of money, over and above their general distribution; they helped a family at times of hardship. Goats are distinguished amongst domestic animals as those most able to feed themselves under adverse circumstances. In a drought, when other animals perish, goats manage to survive. They tend, it is true, to survive at the expense of the reduced herbage. They are, amongst animals, those most calculated to strip the vegetative cover and promote erosion and desert-making, for not only do they bite close, but they are nimble climbers; they can denude a hillside and find sustenance in its coarse, weedy vegetation. So they increase and perpetuate the disaster of drought, as does money when, as debt, it adds to and perpetuates seasonal disasters of Western farmers.

In, 1898 the Kikuyu of Mrs. Huxley's story were first visited by the Red Strangers, as they called the Britons, and in 1902, their elders or councillors at Nyeri surrendered their freedom to the Red Strangers. They were forced to this by magic. The magic of the strangers was beyond all that they had imagined. Under it a mere noise could kill a man many fields away. The Kikuyu magicians strove to oppose it, but they were as feeble against it as were the prophets of Baal against Elijah. The story itself is, indeed, not a little magical, in that an established wisdom, that which had fitted the people so well into a cycle of life, should be at once dispersed because of a mixture of saltpetre, sulphur and charcoal. Neither Kikuyu nor Britain can answer the question why wisdom gets no immediate support from nature, so that these magics at times do

struggle for the survival of the most powerful. What is sure is that *nature in her own time does write her verdict* and she writes it upon the soil. Then she makes herself the measure of wisdom and gives her verdict in its favour.

The Kikuyu cultivated the southern slopes of Mount Kenya at an elevation of 4,000 feet, with a climate in which the northern peoples could make their homes. So, with scarcely any preliminaries beyond the display of magic, the Red Strangers announced that the land which the Kikuyu regarded as theirs, really belonged to a distant king.

The Kikuyu, upon the ridges of the hills, had their enemies, the Masai of the plains. They and the Masai had fought mainly so that the victors could seize the cattle of the defeated. The first thing that the strangers brought about was peace between the Kikuyu and Masai. But it was not a peace that was the counterpart of war, that is to say, a peace between plumed warriors. Like most that was happening, it was so odd as to be inexplicable. The men of Kikuyu were commanded by the strangers to go amongst the Masai peacefully and to carry the possessions of the Masai, while the Masai themselves, men, women, children and beasts were ejected from the land of their fathers and sent to a new land. Under the aegis of the peace, the two peoples met and mingled in humiliation.

As the younger men were deprived of the pride and privilege as warriors, so also their elders found their dignity stripped from them. It was their right as councillors to dispense justice and compel the guilty to pay fines to the injured. But now it was a Red Stranger who took over the dispensation of justice and imposed fines. These fines now had to be paid not in goats, but in round metal coins and when paid by the guilty to the Red Stranger, he did not give them to the injured, but kept them himself. This clearly was not justice but theft. There was no effecting of a balance by means of compensation. The Red Stranger alone benefited, not only by keeping the coins, but by forcing the guilty to do paid work, which the Red Stranger required, so that they might get the coins for paying the fine.

Later came new and terrible demands. The men of Kikuyu were taken from their homes and brought down to the sea, which they saw for the first time. They were put into a wagon that rested on the sea and locked into a room with iron walls, the floor of which, when the wagon moved, rocked under their feet. They were overwhelmed with fear; it was like being in the belly of an animal. They were brought to a strange land, where again they carried loads as porters and served the Red Strangers, whose king was engaged in a very big war. They endured hardships so severe, that those who eventually returned to their home could not speak of them for many years. Such grim memories were the ghosts of great fear.

On their return, some of them did not go back to their original homes, but went to take up new land at some distance from the old, where the Red Strangers were installed. Now they were free and happy to be free upon farms of their own making. But, after a while, quite unexpectedly, a Red Stranger arrived and told them he had

given coins to the Serkali or Government, and because of this all the land and even their farms were his. But he did not, he said, intend to take away their farms or their animals. These they could continue to cultivate, but the men must also work for him. They would work one month for him and get six coins or rupees for the work, and then one month for themselves, and so on, through the year. By this arrangement large fields of maize were grown and many beasts were pastured for the stranger, and the Kikuyu kept their farms in cultivation and received coins.

The early result was surprisingly good. They got their silver coins every second month and what was more, the Red Stranger knew of markets where they could, for more coins, sell the surplus products which the virgin land produced abundantly. So coins began to accumulate. One odd thing, however, happened. It was the Serkali who gave out the coins. Nevertheless, the Serkali would not let them keep all the coins they got, but asked for some of them back. As the Serkali themselves made the coins, this was another insoluble puzzle. But, though some were given back, there was still a goodly number left, either to be buried in the floor of the hut, or to be put in the post office to be spent, when opportunity occurred, on taking up more land and a second wife to work upon it, and more goats for pasture. So, under the leadership of the Red Stranger, who now became in some sort a friend, riches, that is to say land, wives, and goat,s became more plentiful and the future held out hands of promise as never before.

Then something happened that neither the old nor the new magic with its new coins could avert. There were two years of drought, terminating with locusts and famine. The Serkali sent food from outside to the people, whereby they were saved from actual starvation. There followed a season which seemed to concentrate its own rain with that which should have fallen in the two previous years. The crops were now not burnt up but drowned. Further, in spite of the great shortage brought about by the drought, when any surplus product was now taken to the market, instead of many coins being given for it, for some reason inexplicable, so few were given that they did not balance the cost of cultivation.

The Red Stranger, who had taken their freedom from them, nevertheless had helped them and become their friend. He was now filled with sorrow, and in sorrow he dismissed some of those who worked upon his big fields and paid fewer coins to those that remained. There followed a further season of drought, when the unclouded sun beat day after day upon the land. The lake in the valley shrank to a lowness unrecorded in living memory. The pastures, stripped by locusts, turned to powdered earth, and dust-devils whirled across the valley like wild dancers. Erosion had begun. It was as if the new treatment of the old earth made the soil become something ghoulish and caused it to tear itself from its home and flee in towering columns with the wind. So it escaped from the Red Strangers, which the Kikuyu could not do.

As has been said, something had gone wrong with the coins of the new currency and it was now found necessary to contract or cut down the currency of the Kikuyu. The Red Stranger, whom the Kikuyu had had to obey and had come to trust, issued an

order to them to limit the goats, first to ten goats for each married woman, and then five. But this too failed, and the stranger, having no coins left, gathered his family together, bid a sad farewell to his sorrowing Kikuyu friends and was no more there.

In his place came another and with him an officer of the Serkali. Then fell the final blow. All the goats, which in their hunger were eating down to the very roots, were expelled from the stranger's pastures. The Kikuyu, who worked on the large fields, were allowed to continue their work, but they must have no goats. If they wished to keep goats, they and their animals must go elsewhere.

In this way the traditional currency of the Kikuyu peasants, that which had been to them what the coins had been to the kindly Red Stranger, was as effectively destroyed, as was that of the peasants of India by Act No. 8 of 1893. It was replaced by a currency which had no relation to the local returns of the soil, as had the goats, but was something quite outside the humble fortune or misfortune, which work and the seasons brought to the Kikuyu. The new currency, it is true, brought with it certain advantages. In times of actual famine, it was able to relate the Kikuyu to better conditions far distant from their locality. With it came trade, education and the creation and improvement of towns as means of livelihood. But it took away something that was an essential part of the life-cycle, an automatic animal factor upon the farms, which rose and fell according to the creative capacity of the soil. When severe adversity came, the animal life was diminished; it was only extreme and rare disaster that had a like effect upon human life. Being a part of the life-cycle itself, the currency moved up and down with the favourable or unfavourable condition of the soil. The new coins, on the other hand, had no relation whatever to the soil, local or otherwise. They were completely dissevered from it. They had, indeed, the agricultural impossibility of having nothing at all local about them and of having an existence entirely apart from the life-cycle. They were related not to the soil, but to world finance, the first modern attempt by a group of men to be masters of the world.

Without their goats the Kikuyu were like the friendly stranger without his coins, and they, too, in their despair, followed his example. They packed up and left the land of their adventure to return to the land of their forefathers.

In the further narration of the fortunes of this family, Mrs. Huxley skilfully contrives to give an epitome of the Kikuyu people, as a whole, in their transition from a subsistence to a capitalistic farming basis, which with its ancillaries occupied in years as many decades, as it took centuries in England, so swift was the tempo. Nevertheless, all the main features reappear in the Kikuyu story. The large estate and the extrinsic money system have already been described.

The family returned back to their homeland, confident that, according to tribal custom, they would have a right to the land, which the father, when young, had cleared at the side of a forest glade. But, on their arrival, they found changes even more varied than those they had experienced in the land of their adventure. A cousin had taken over both the land and the glade. The glade had been turned into a pasture,

and it had something unknown in the past, in a fence which enclosed it. Previously all pasture had been open and the common ground of the villagers. Fields in the past had had temporary fences to protect crops from wild pigs and other animals, but the fencing they now saw was substantially made and not the temporary fence of custom. The cultivation of the fenced-in fields was also different to that which they had expected. The native method of hoeing by hand had been supplanted by a plough with oxen to draw it, and they soon discovered that there were other new ways of cultivation, such as a rotation of crops. Still more surprising was a square house built of stone, with windows, a veranda and a shining iron roof, and about the house was a garden with flowers and with fruit trees planted in rows.

The family looked about for goats, but saw none at all. That animal, once the currency and also the victim of religious sacrifice and so in two aspects closely interwoven with men, they later found had, under British advice, been entirely discarded. There were some other measures of wealth, and then they realized that what they had seen of the home of the Red Stranger in the land they had left, was here repeated. They were looking, not at communal or tribal land any longer, but at something more like to the estate of the Red Stranger. So they saw and, asking many questions, they learnt that the cousin himself had become as the Red Stranger, one who, by the right of the Serkali, claimed that the land was his. They were looking on *private property*.

Certainly this cousin had benefited greatly by means of the Serkali and by listening obediently and intelligently to its agricultural officers. As a progressive man, the Serkali had made him something new to the Kikuyu, though not, had they known it, strange to the English Red Strangers, something derived from the lord of the manor. They had made him the local land-chief and he had become so rich that he had no less than twenty-two wives to serve him. Even the form of the wives' service was strange, for it was they and not the cousin's men who tended the cattle. There were sons enough for the work, but they had all of them been to the schools of the Serkali and this placed them above tending cattle. Education was something which turned the young men from the land to the town, where they became clerks or teachers or policemen or took other forms of subordinate service to the Serkali. In these services there lay a greater safety, a prior claim it seemed upon the Serkali, for in Nairobi, the capital town, during the long drought and famine, these younger people had still had enough to eat, still travelled comfortably in omnibuses to their work, still dressed in European clothes and danced in European fashion. The great affliction of the countryside was fended from the town.

The returning family saw and heard all this. Particularly, of course, did they note what concerned them most, the stone house, the rows of fruit trees, the cattle, the fencing and other changes upon the land that according to custom was theirs. On the one hand, then, was their traditional right, on the other the robust facts of private ownership. The father, now an old man nearing his end, wished to bow before the power of the new, the son was unwilling and prevailed. And so a claim for the land was lodged by the family.

The case aroused the keen interest of the whole locality. It staged the conflict that was everywhere diffused between the old and the new. The elders stood firmly for the tribal laws of inheritance and the safe living upon the land which they gave to each family, and opposed the new rights, which made men dependent upon the will or whim of so-called owners of the land. The younger generation stood as firmly for the cousin, because of the improvements he had made under the guidance of the Serkali's experts. This, they said, made the land his. As to the family, if dispossessed, there were other ways of getting a living open to them, such as by becoming labourers upon the roads or railway or in house-building, or porterage, or even in Nairobi, by acquiring dignity as taxi or bus drivers. They could even stay on the land in the humble form of hired labourers, receiving wages from the new owners.

As the claimants could not afford to pay compensation for the improvements, the land was finally awarded to the cousin. But the claim of the family was also acknowledged and land, belonging to the clan, was awarded of equal size and excellence to the original clearing by the forest glade.

So, after many experiences of sudden and quite unpredictable changes of fortune, the family attained once more to the traditional security of the homeland. But even here they had to submit to the fringes of what was to become by far the most dangerous change of all.

The old father died and he left behind him one legacy. It was a prophetic pronouncement of his not long deceased friend, Irumu, who had been the seer of the tribe: 'When women walk all day to seek firewood and when cultivation lies naked under the sun, then shall evil come. On the days when trees again darken the ridges and bring shelter to the weary, then shall good fortune return.'

From the deep, inward oneness with the local life-cycle,, which such tribal wise men have, had arisen a vision of the coming of the Great Erosion. Where the new greed for land as property caused too many trees to be felled along the ridges of the hills upon which the Kikuyu had their homes, there the torrential rains would be unchecked by these umbrageous ramparts. The watery bullets would pound some of the top-soil into mud, which escaped in turbid runnels down the slopes of the hills. This was the beginning of water-erosion, which as it spreads causes women to walk all day in search of firewood. And when the fields were broken open by the plough in place of being lightly stirred by the native digging-knives, and when they were made to grow one crop in place of several plants of different heights, foliage and roots, then the cultivation lay naked under the sun. A dry season made the surface of the soil dusty and some was blown away by strong winds. This was the beginning of wind erosion.

These two erosions form the last phase of the present story of the entry of the Kikuyu peasantry into modern civilization. Due to this civilization, there was a greater call upon the fertility of the soil and in some strange way a similar call on the fertility of its partners, for a native proletarian population increases under the early rule of the

Westerners. Many new ways of earning the new coins were opened up. The colonial governments called for more coffee, more sugar, more cotton, more hides, more maize, more sisal and so on for export. More land was exposed for cultivation, its fertility taken up by the crops and the rule of return neglected.

Here is an account of the last phase of this process as it is affecting the Kikuyu, written by Messrs. Jacks and Whyte in *The Rape of the Earth*, 1939. This account completes the story so brilliantly told by Mrs. Huxley.

Erosion, they write in their world review, has attacked the lands of the Kikuyu, and it is due to agriculture being forced to too speedy a pace in 'the increased desire to obtain cash through the sale of crops' and in the need for more food crops by the increasing population, much of which migrated to the growing towns.

The original mixed farming for sustenance succumbs to the new commercial farming, *it does not everywhere form the basis for the new*. One farmer will concentrate on the growing of maize, another will stock or overstock the land as pasture; both practise thereby a rape of the earth. They farm for cash, and, not heeding the rule of return, they take more fertility than the soil can recurrently yield. They treat the soil as conquerors and not as partners.

In the general demand for more crops, the peasants cultivate not only the ridges upon which they had their homes, but also the easier slopes of the hills. There comes a loss in the quality of the soil, a loss of that wonderful air-containing, loose adhesiveness of the soil due to good humus, and with this degeneration the great natural elements of rain, wind and sun, once friends and partners, now, at the times of their especial strength, become enemies. The Serkali has taken no proper measures to prevent this. There is a 'lack of conservation measures in general', say Messrs. Jacks and Whyte.

The European owners mostly exhaust their estates by the same disregard of the precepts of nature. They override nature before the fall. 'In the European areas erosion is caused by exhaustion of the soil through long continuous cropping without the adoption of methods to prevent erosion and maintain the humus content of the soil. The results of land misuse are only now becoming apparent in a grave form, as much of the land in the settled areas has only been cultivated for fifteen to twenty-five years. Some areas of Kenya have already reached such a state of devastation that nothing short of the expenditure of enormous and quite impossible sums of money could restore the land for human use above a bare and precarious subsistence standard ... Generally speaking, erosion has become serious only during the past five years. In addition to the causes enumerated above, the invasions of locusts of 1929-31 and the drought of 1931-5 greatly accelerated the process and were largely responsible for making it so apparent in the space of a few years.'

The Red Strangers came to the land of the Kikuyu in Kenya, because, though situated upon the Equator, it is highland and has a climate in which they can live and farm.

They make their homes there, but to maintain their accustomed standard of living and to save money, they concentrate on farming for profit and in this they do but follow the common lines of modern farming. The facts that the fertility of soil is exhaustible and that methods, under which in the cool, wet climate of Britain the soil is slowly depleted will, in Kenya, deplete it with rapid momentum; that sun, wind, rain, goats and cattle, all fitting into the old life-cycle, will thereby be turned from partners into enemies -- these are foreign to their experience and knowledge. In their own land the rule of return and the conservation of humus are not axiomatic.

So they farm and so, wishing the Kikuyu to share in the wealth from the new methods, they induce them to adopt the new values.

The intention is good. Both white men and black shall profit by progress and science. Though the Red Strangers, with their greater magic, claim the land as belonging to the distant king, any further exploitation of the Kikuyu is not the king's wish. In July 1923, His Majesty's Government itself decreed that the interest of the natives must be paramount over those of all immigrants, including the British, and that on no account were the black men to be sacrificed to the white. The Red Stranger, who announced to our Kikuyu family that the land had become his by the payment of coins, nevertheless, as befitted this good intent, soon became their beneficial friend. 'They understood then that they, the black, were not to be sacrificed to the white.' But both black and white depended upon the soil and it was the soil that was sacrificed. It was stripped of its sheltering cover with eager haste and a tragic lack of understanding. The final result is not yet known, but what is known is sufficient. In some parts, in very truth, the words of Irumu are no longer words but facts: the women walk all day to seek firewood and the cultivation lies naked under the sun. Can the days, of which he spoke, cease to be words and too become facts: 'On the days when trees again darken the ridges and bring shelter to the weary, then shall good fortune return.'

Money, that has been the root of this evil, is *unable to save*. The authorities quoted say that only enormous and quite impossible sums of money could restore the land. And before money, representing effort, there must be again the change of values, a change of outlook and a change of faith.

Nature is very careful, but men are careless. In some of the species of acacia trees in Australia, the leaves are suppressed, and the leaf-stalks or petioles are vertically flattened to take upon themselves the function of leaves. It seems that the vertical. position of these petioles prevent injury from excessive sunlight, as, with their edges to the sky and earth, the petioles are not so exposed to the light as are the horizontal leaves. Scientific theorists explain how this comes about, but to the thinker, it is an exquisite example of nature's care, and should impress farmers, telling them: 'Do likewise. Exquisite care is necessary in the preservation and adjustment of the details of life-cycles, and that is what farming should be.'

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by G.T. Wrench

Chapter 12

Nyasa

Here is the story of another primitive farming people of East Africa, about 1,000 miles south of the Kikuyu and occupying highlands of lesser elevation at about the same distance from the sea.

In 1935 the Government of Nyasaland became perturbed by the increasing exodus of able-bodied peasants from the homeland. The Governor appointed a committee of inquiry. How alarming the exodus and its far-reaching consequences were was revealed to the members of this committee. As they travelled and saw and questioned, vista after vista of the tragedy of native life was disclosed.

This is what they reported: 'We must confess that, six months ago, there was not one of us who realized the seriousness of the situation; as our investigations proceeded we became more and more aware that this uncontrolled and growing emigration brought misery and poverty to hundreds and thousands of families, and that the waste of life, happiness, health and wealth was colossal.'

Now this statement of a well-intentioned committee is worthy of the closest attention. At the outset it should be noted that there was not a rural native upon the committee. It was assumed that wisdom lay outside the land. The committee men were not terrene men, measured by the axioms of the soil, but super-terrene men with very little knowledge of the terrene men of the land of Nyasa. Consequently, within six months, they found themselves astonished, even overwhelmed, by the disruption of a terrene life-cycle, involving many humble people, for whom they and their kind were responsible. The wealth, of which they wrote, was the wealth of the land, and they laid down their belief about it in these words: 'We consider it essential that the whole Protectorate should be surveyed by local agriculturists with the idea of discovering the best uses to which the land can be put, regarding the land not as something to be exploited piecemeal, but as the sole capital of the Protectorate.'

The language, one will note, is that of money-minded men; the land is called the *capital* of the Protectorate; as capital it must not be exploited for industrial profit, but put to the best uses as the only means of livelihood for the people of the Protectorate. How this was to be done was to be decided by local agriculturists. This term did not include native farmers, because they would not be capable of surveys with an accumulation of facts and figures from which to draw conclusions. The committee men did not seek a renovation of the indigenous social and farming life, from which improvements could eventually develop, but advised the consideration of the question from the up-to-date Western agriculturists' outlook. In that way it could be decided how to put this particular *capital* to its best uses.

The indigenous methods by which the natives of Nyasaland farmed had general resemblances to those of the Kikuyu. They cleared a part of the forest and cultivated it as long as it gave good results. Then they abandoned it for a number of years, in which, by encroachments from the neighbouring forests, it reverted to the natural plants and conditions of the country. This is called shifting cultivation.

'Shifting cultivation,' write Messrs. Jacks and Whyte, 'although it kept men as unimportant servants of wild nature, maintained soil fertility indefinitely, since the forest drove the cultivator out and re-assumed its beneficent control as soon as any sign of soil exhaustion occurred.' The indigenous method, therefore, included as a practice, if not as an intellectual precept, the indefinite maintenance of soil-fertility. The Western agricultural, money-making land-owners only awoke to the devastating effects of the loss of soil-fertility after it had markedly occurred, and then devised methods of preservation.

This is because dominant money falsifies conservative farming. The whole conception of money plus interest is foreign to the soil. When money is lent, it is in the expectation of getting not itself, but more than itself in return, an additional creation called interest. But a crop does not reproduce more than the substances it gets from the soil and the air. *The creative power never creates anything extra*. It changes forms. In nature there is only transition, not addition. The conception, then, that money can produce extra money, something over and above itself, is not one derived from the creative power of the soil or the character of nature, and that no doubt is the ultimate reason why interest has been so strongly condemned by religions and philosophies. Peasants feel it to be wrong and the poets, who in Dante's definition are 'those who know the secrets of nature', the 'makers' of the Greeks, know it to be against nature and unreal and therefore inimical to the intellect and morally wrong.

For these reasons money-directed farming, however scientific, cannot create the honest constancy of equivalent return. It strives to get more than it gives, and thereby brings about a difficulty in actual survival. It is this which constitutes the story of Nyasa. Money-directed farming was expected from a primitive people by a government belonging to the money system. The primitive people belonged to a

completed life-cycle, in which surplus crops were exchanged for other human needs. There was no space in their work or habits for anything over and above this completed life-cycle, nothing, that is to say, which could be stored away as dead capital or discarded as not wanted. It would be turned immediately into wealth, which meant cattle or other such visible 'goods' of the native. It certainly could not be symbolized and banked. Consequently when the Nyasa Government demanded a hut-tax to be paid in money, it drew the peasants into the money system without any preparation or aptitude for it and without defence.

They could have paid the tax in goods or kind according to their custom. But they had not the coins which the Government demanded, and their own elder men, in their own urgent need for the coin commanded by government, ordered the younger men to pay the bride-price in coin, not the conventional cattle.

The cash asked for by Government through taxation, wrote the committee in their Report, was considerable. It was more than a farming district, after providing for subsistence, earned. The committee gave, as examples, five districts, which had to pay taxes of £18,000, though earning but £14,000, made up of market earnings £1,000 and wages £13,000. In response to these urban infiltrations amongst primitive farmers, therefore, none of them proved to be 'the fittest to survive' upon the land of their fathers. There was only one thing to be done, as was done in England by many of the harassed Tudor and Georgian peasantry; they had to evict themselves and seek employment in the modern, Westerners' mining, towns of Tanganyika, Rhodesia and the Transvaal, all of which could be reached on foot. Hence, out of a total population of 1,600,000, there were 120,000 farmers continuously out of the country, 50 to 60 per cent of the able-bodied population. Basutoland and Swaziland, farther south, had almost the same percentage of young workers absent from the land. The workers, partners of the soil, were disintegrated and blown, as it were, like eroded soil, to regions where they were made to take from the earth, not crops, but the gold that was then the god of the money system. 50 to 6o per cent left their farms; yet the Government of the Belgian Congo had been advised by one of their committees that even the absence of 5 per cent of young able-bodied men from an African village upsets the whole economic and social balance of the community.

There is scarcely need to give a picture of the state of the peasant families who remained; of the women, the old men and the elder children, who strove to carry on the cultivation of the land; the fields overgrown with weeds and jungle invasion; the huts falling to pieces; abandoned fields and crumbling villages, as if the Tudor period flung a long reflection of itself upon Nyasa and the neighbouring lands.

A partial remedy came through the unchastity of the married women. Wearied by the unequal battle and the increasing illnesses of themselves and their families which accompanied it, they gave up the attempt to remain chaste for their husbands' return from the mining towns with the cash and the venereal disease they had there acquired. So, when natives of Portuguese East Africa discovered that there were women and land across the border, they seized their opportunity. At the present time, it is said,

there are as many, or even more, such male cuckoos resident in Nyasaland as there are Nyasa men.

The story of Nyasaland tells that 'waste of life, happiness, health and wealth was colossal'. It is a tale of the misery of a shattered life-cycle. It is not a tale for the heart only, but for the brain. It is an expected tale. History does repeat itself over and over again. Post-Punic history and Tudor history, with their evictions and brilliancy, are repeated in the story of Nyasaland and its neighbours. Distances are greater and the brilliance was to be found distantly amidst the wealthy of London and other cities, and those who derived something from them.

But the modern story was debased by its being one caused by naked gold itself, to mine which the peasants went from their farms to earn cash, for the taxation by coin that was put upon them. It is a tale of the immediate contact of the raw material of the money-system itself with primitive farmers. The foes were face to face.

Some readers may sometimes have wondered why primitive peoples seem to die out with the 'advance of civilization'. Here is one way. It shows directly how the money-system acts. It is the system, which elsewhere is represented by high explosives, bombs, tanks and the rest. But against the soil its weapons are not known as weapons. Nevertheless, through them, the money-system is far more widely and more permanently lethal than it is by the destructive efficiency of its machines. It kills at the source. It kills the partnership of the soil and the peasants. Wherever it is in action, it produces an eventual desolation of death; peasants and soil vanish and with their loss, what was a source of healthy creative power is given over to death.

Chapter 13

Tanganyika

Between Kenya and Nyasaland lies the great, sparsely-inhabited territory of Tanganyika. In this territory, there is a life-cycle of a very remarkable character, which contains within it, as a part of its ecology, an insect, the tsetse fly. This fly has come to play the part which the lions of Judah once played as defenders of the natural forest against the intrusions of man. Palestine no longer has its lions and the consequence is that, when one flies over it in an aeroplane, one looks down upon the watershed to see barren rock where there should be forest.

The tsetse's method of defending its forested life-cycle is more subtle than the terror by which the lion once kept men from his home. There is nothing regal about the tsetse, but its part in its life-cycle forms one of the most remarkable in nature. It feeds like the mosquito, upon blood, biting both animal and human. Tsetse is also a host of the microscopic trypanosome; consequently when it bites it may inject the trypanosome into the blood of the bitten animal. When it injects animals in its own

life-cycle, the animals live. The trypanosomes do not harm them more than a number of microbes, which live in men, harm their hosts.

But if man's domestic animals and man himself invade the tsetse area, it is a very different story. On the expedition to Tanganyika, to which the Kikuyu peasants were taken as porters and endured such miseries, none of the animals imported into Tanganyika in the service of the British Forces survived. Practically all that were not killed accidentally succumbed to the fly. It is destructive too, to men. The first trypanosomes were brought by cattle driven across the watershed between West and East Africa. In parts of Uganda the tsetse lived. They became the hosts of the trypanosomes, and 200,000 out of 300,000 people died in six years.

Men, therefore, have a very great fear of the localities of this insect, a great fear like that of past Palestinians for the lions of their forests. The tsetse evicted them and their cattle from its forest areas. It is said that in the full 365,000 square miles of Tanganyika, two-thirds of the five million inhabitants have to confine themselves to one-tenth of the total territory. Then came scientific white men determined not to be evicted by, but to evict the insect. So they cut down the trees and bushes near the streams, lakes and pools, in the shade of which the tsetse lives. The result has been an erosion, not so threatening and extensive as in Kenya, because the area that is cultivated is so limited, but so serious as to call a halt. It was clear that trees must be left to protect the soil against the heavy rain of tropical East Africa; otherwise the forest became savanna, then coarse grassland and, eventually, if this poor pasture was over-stocked with cattle, barren waste.

The hydrological or water-cycle, in which vegetative cover plays an absolute part, had to be preserved, and consequently the wholesale destruction of the haunts of the tsetse along river and around pools and lakes had to be abandoned. In its place very cautious ablation of bushes and trees favoured by the fly, is being tried. Indeed, in no part of Africa probably has the value of distribution and conservation of the water supply been more thoroughly grasped than in present Tanganyika. In the Kilimanjaro Native Co-operative Union, which claims 24,000 members out of the 36,000 farmers on the slopes of Kilimanjaro, there are 26 societies, and the reason of this number is that it corresponds to 26 streams, which take their origin in the great mountain and water its slopes. Under the guidance of Sir Donald Cameron, geologists, plant ecologists and water surveyors have been linked together to fit farmers in an understanding manner to the local character of the water supply as a whole. They have marked out the catchment areas of the 26 streams. Each catchment area with the river to which it gives rise has been made into a separate entity and is presided over by a native chief, and the 26 entities united in the Co-operative Union; 26 catchment areas, 26 rivers, 26 cultivated areas, 26 chiefs, 26 communes, and one Union. It is a real association of communes and the assembly of the Union a real House of Communes or Commons, people of a common source of life and not the mixed mockery which the Assemblies of Communes have elsewhere become.

So in the strange way in which nature replies to human acts, man has been shown that

the tsetse, which has been such a prolific killer of him and his animals, has nevertheless proved a great saviour of the source of terrene life, the soil. Had it not been for the tsetse, the rich soil fed by the greatest mountains of Africa under an Equatorial sun, would have been greedily seized upon and its stored fertility turned into cash, until an irrevocable erosion stayed further ravages. But, owing to the tsetse, this swift onslaught could not be made. The tsetse has prevented it; in the words of Mr. R. 0. Whyte 'the presence of the tsetse in many parts may be a blessing in disguise, as it can be regarded as the trustee of the land for future generations'.

The tsetse is a pest to man, but man, greedily eager to make his fortune from stored soil fertility, is a pest to life itself. So the strange story of Tanganyika ends with the little tsetses still defending their waterways against the lords of the earth, so giving time for nature in her own ways to tell these lords that, masterful though they may be, if they claim to be *masters of nature*, they are doomed. They themselves must re-learn with humility that they are the *creatures* of nature, and, this time, a little insect shall teach them.

Chapter 14

'Earth Thou Art'

Before continuing the story of the present misfortunes of the, soil, it is well to recall again how earthly we ourselves are. This may be done by a meditation, in which one concentrates the mind on some one thing of those so common to us that normally we never trouble ourselves about them. We concentrate and allow our minds constantly to widen the circle of thought that arises from this concentration. We are accustomed to give a good deal of time thinking out our problems, but we rarely meditate, we rarely make ourselves strange to the familiar. We accept the air as air, the sun as sun, the earth as earth without at any time making ourselves strange to them until we comprehend both them and ourselves in relation to them.

'Earth we are and to earth we return' is a sage and familiar saying upon which we may well widen our reflection. It seems that this earth now under our feet is in some way us. To it and its darkness we and so much else in the world of light belong. The interchange from the visible to the invisible and from the invisible back into the light, is continuous. We ourselves, as part of the visible, are largely concerned with the invisible. The great majority of men trouble little about it, but since man is, it seems, the sole creature of the soil that is endowed with meditative thought, he has gathered a good deal of knowledge of the crust of his planet. Deeper than the crust of the earth he can scarcely reach, but in it he searches from a wide generality of instinct, which tells him that, though he has spirituality, he is nevertheless essentially terrene, and when he searches into the earth, he searches for a further understanding of his own being.

Living in the visible world, he is destined to return to the earth. As electricity can be separated by him from the earth and made to run trains, drive ships, bathe night cities in radiance, and draw great clouds together over thirsty lands, yet like man it has its earthy phase and to the earth it must return.

Similarly man, in his farming, separates land from its natural state of forest and prairie. There he grows products for his use, but in the end they too are destined to return to the earth.

So also it is with water. Water rises invisibly from the ocean and ascends to the skies there to take visible form as clouds. Thence it descends again to the earth and takes visible form upon it as brooks, rivers, lakes, ponds and dew. Man, too, separates some of it for his purposes. By irrigation he waters his fields, by conduits he waters his cities, by tanks and reservoirs he waters himself. But eventually these waters return to the invisible, they sink into the earth or the depths of the ocean, from which once again they come back to the visible world.

We human beings, whose substance plays its part in these transitions, are conceived by the sparks that set our being in motion and spring from the mystery of creation. But from the very moment after the two sparks, male and female, unite, we are in growth of the earth earthy. Heredity, in all its variety, comes from two cells so small that they need the microscope to make them visible. In these two cells for us and other beings of the earth, there is the magic of predestination. It is they that determine the launching of man or animal or plant. In man, they determine sex, colour, character. Though only two specks, they have within them a multiplicity of destiny that is quite beyond our understanding. We know there are so many *genes* in each cell, but to know such mathematical details, though most acceptable, is not to understand its mysteries.

In this early stage, as in later ones, we receive the means of growth from the earth and from those things which also have their earthy phase, the air and water. These means of growth are made up of substances, many of which have been separated as entities, by the knowledge of man and called by him elements. There are only ninety known elements, but they occur in so many combinations, that we should be entirely lost if we had to manage them ourselves. It is nature that manages them and their interchange. This we know, that otherwise there would be no life. Nevertheless, we boldly again isolate elements and certain combinations, identify them by tests, weigh them and give our names to them and try, as it were, to come to some stable and positive relation towards them, calling a halt, for the time of our own being, to their constant transitions.

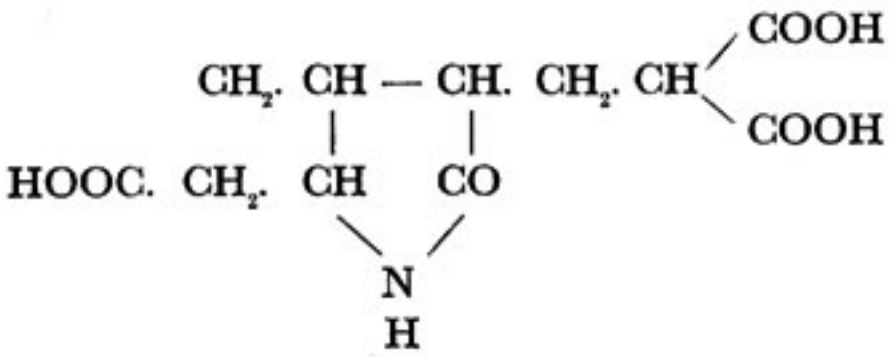
These are the elements that have been found to be a part of human bodies: nitrogen, oxygen, carbon, hydrogen, sodium, potassium, sulphur, iodine, fluorine, manganese, silicon, cobalt, copper, iron, zinc, lead, arsenic, lithium, magnesium, aluminium, boron, chromium, strontium, cadmium, barium, tin, vanadium, titanium. Some of

these twenty-eight elements may not be essential to human life. But they are part of it, for all have been found in sewage sludge. They may, one hazards, be essential, if not to life, to certain qualities of life.

The four great elements of our body, our brain, our thought and our affections, nitrogen, oxygen, carbon and hydrogen, are all aerial, as if they have to pass to the heavens for their purification before they turn with pristine vitality to the earth again. Perhaps there, bathed in the rays of the celestial bodies, they gather that marvellous power of combination, which makes them the supreme elements of life. In their endowment of life they show a singular affinity for each other, an affinity so dazzling that it blinds our very thought in conceiving it. They associate together in innumerable patterns, as if in the great spaces from which they come they had become like Wordsworth's birds displaying

Hundreds of curves and circlets, to and fro,
Upward and downward, progress intricate
Yet unperplexed, as if one spirit swayed
Their indefatigable flight.

It is the four of them that, joining together in almost uncountable varieties, form the proteins of living substance. Some of their steps in the protein dance have been separated out by the cold skill of the masters of organic chemistry. These steps are called amino-acids. Here is one and this is how it is written: six atoms of carbon, thirteen of hydrogen, one of nitrogen and two of oxygen, or (CH3)2:CH. CH2. CH(NH2). COOH. Or they may be spaced like this:



The number of possible proteins is quite beyond men's imagination -- Berg gives them as 6,708,373,705,728,100 -- and the transition of associating elements from one temporary form to other forms gives one a glimpse of the constant and amazing variety of living nature, before which man can only, with such glimpses as he has gained, regard his own creative and manufacturing power as something, excellent though it may be for him, yet very lowly and humble before this whirling, form-making artistry.

When nitrogen steps aside from this quadruple partnership and leaves carbon, oxygen and hydrogen, the three again meet and re-meet in the less dazzling combinations of

the carbohydrates or starchy and sugary substances of living matter. They too are illustrated by the chemists in formations more regular, but nevertheless as wondrous as when nitrogen takes so vital a share. Here is a common sugar, dextrose, CH2OH. CHOH. CHOH. CHOH. CHOH. CHO. Were this form placed amidst a number of surrounding mirrors, there would be an equivalent number of reflections. There are actually sixteen of those reflections to the above sugar, dextrose, four of which are found in nature, twelve prepared synthetically by Emil Fischer and others, but not yet found in nature.

There is something sober and shapely about the carbohydrates; for the majority of them are so many atoms of carbon in combination with so much hydrogen and oxygen, combined as they are in water or H20. This cannot be said of these three elements, when nature with her marvellous jugglery uses them to make the fats. Here for example is an arrangement which makes a fat: C3H5 (O.CO.C15H31) (O.CO.C17H33) (O.CO.C17.H35). Even with this jugglery with the three elements in the making of food substance known as carbohydrates and fats, nature is not content, but from them she fashions certain hormones, which have a governing power within the body, such as the hormones of the testes and ovaries and also one of the adrenal glands which in excess can give a beard to a woman with other qualities of masculinity. Some of the popular vitamins are so made. By adding nitrogen there result one or two other hormones and vitamins, and yet again with the addition of iodine and nitrogen the hormone of that very dominant gland, the thyroid, and, with nitrogen, sulphur and chlorine, the well-known vitamin B.

When one reverently meditates upon these four marvellous aerial elements, is it strange that man, who derives so much of his vitality and the fabric of his spirituality from them, should not almost from the beginning have felt his intimate unity with the pellucid heavens above him? Truly it seems that he has a heavenly, as well as an earthly body. Yet, in his murky worship of money, in his manufacturing cities, he shuts himself off no less from the clean air than he does from the clean earth. We know that in consequence he is less whole and healthy. We know that he has to go to the sea side or the country to recover some of his aerial factors. We know that authorities have to plan camps for children and adolescents to go under the open sky. We know that we have to install plants of artificial sunlight in the cities as a treatment for the most obvious cases of deprivation of natural sunlight. We do not know how wide, subtle or deep is the total extent of deprivation, because our wholeness within the life-cycle is unknown to us and, at the most, only the subject of fragmentary research. How then dare we to proclaim ourselves the masters of nature and the lords of creation, we who have broken our own life-cycle, divided ourselves from its earthly and heavenly elements and look to mortal men of mediocre health and physique, sitting in their laboratories, for guidance in these immortal truths that are clearly evident in our inward feelings and written upon the open face of the great sphere where we live?

There are other aerial elements, argon, crypton, neon, xenon and helium, of the relation of which to life we know little or nothing. We will return then to the terrene

elements. How many of the twenty-eight already named in this chapter are essential has not been determined, but it has been discovered that mere traces of some of them are essential. Thus, in the case of the black rot of sugar beet, it has been found that this disease occurs if there is lacking a necessary trace of boron in the soil. Similarly, a trace of manganese protects oats from black speck. A fatal disease of sheep in parts of Australia and New Zealand is made curable if a little cobalt is added to the soil. In Florida cattle were found to die until a trace of copper was put in the fields, in which they pastured. It is probable, then, that all these twenty-eight elements are workers and that none are drones in the cycle of life.

There is, then, a procession of the elements and, though there is no pause in it, it may be said to start in the microbic and fungoid stage in the soil. In man's cycle, the procession starts in man himself, for the breaking down of waste substances by microbes begins in the lower bowel. Microbes in health are friendly microbes. Their hostility only appears when living matter seems to lack what we call quality. Then they set about hastening the return of the living matter which lacks quality to the soil. By far the greater part of the microbic world is, then, not only friendly, but it is merely ourselves in a different form. Our elements are their elements. They make us and we make them. Therefore, when we concern ourselves about them, we concern ourselves with what we ourselves are. This is a secret of healthy food. If we take elements out of the cycle and disperse them in the sea, we are robbing ourselves. The microbes then take measures, as it were, to save themselves. Unfriendly microbes multiply. One witnesses, in fact, a break in the *mores*, the morality, of the microbic world. The microbes start exploiting the weak for their own benefit, they become aggressive, bring the weak to the ground and become emboldened to attack the strong. But it is the *original weakness that brings about this break in morality and turns one phase of the procession of the elements to become the enemy of another phase*. The microbic theory and money-dominance are certainly no strangers to each other.

It can all be so different. These marvellous elements are like the notes of the piano, which under skilled and reverent treatment produce an infinite number of melodies and harmonies. In the rhythm and the completeness of the forms they make in the natural world, one can indeed see a wider picture of that music to which the ancient Greeks gave the highest place in human culture. Misplaced they make cacophony, the hideous cacophony that now roars throughout the inhabited globe.

Man must revere and respect these elements. He must lose none, he must spoil none. He must consider them wherever and however he meets them as a part of a great being and becoming in which he has his share. Whether as non-farmer or farmer, *it should be his wisdom to understand his life-cycle and keep to it*. He should know that, as man, he tends to be so anthropomorphic, so self-centred, that he interprets food from his own point of view only. He thinks of it as things of the day, the market and the shop, as bread, vegetables, meat, eggs, fruits and milk, or as things of the factory, processed, preserved, tinned, bottled, dried or dehydrated, or as things of the field, as

growing grains and vegetables and fruits upon the tree. He thinks of them as things in themselves, as indeed he must do in the daily traffic of life. But to preserve quality in them and to maintain quality, he must also think of them as transitionary parts of a whole. This he has failed to do. *It is a failure in thought and observation*. With that failure he has become, in the words of the great seer, F. H. King: 'the most extravagant accelerator of waste the world has ever endured. His withering blight has fallen upon every living thing within his reach, himself not excepted.' He pursues the path of race-suicide, while he chants the hymn of progress.

He is terrene and everything that is terrene is of importance to him. He is of and for the earth. As the sugar-beet gets black rot without its trace of boron, oats get black speck without their trace of manganese, and sheep, 'pine-sickness' without their trace of cobalt, so he also requires such final sculptural touches for the perfection of his physical and mental health. If he depletes his life-cycle, he is himself depleted. In the intelligent United States, the depletion of the soil has awakened alarm, and scientists now make statements which seem extreme but may well be true. Such statements are that 99 per cent of the American people show some lack of minerals. Dr. Sherman, of California, has said of his people, what Sir John Orr has said of his, that above half the people suffer from calcium deficiency. Dr. Northen, of Alabama, added a number of minerals to the soil and found that, though vegetables and milk produced by it had the accustomed appearance, they had a very different mineral content. Quite new standards are, therefore, needed.

Textbook analyses, once made, stand. But often they are standards set by a soil that has been injured by faulty practices. So they are faulty value standards. We need the standards of the perfectly healthy soil.

Man's bodily substance, when not lost to the sea, returns to the earth many times in the course of his life. The grim saying, 'Earth thou art and to earth thou shalt return', said of his dead, is no less true of his living body. He is a terrene animal, of the earth earthy. That he cannot escape, and so he lives as a product of the soil to conserve it or deplete it. At present he depletes it. The story of this depletion is in its way mystical and inexplicable. It is one of retributive justice. The old doctrine that sickness and wars were the punishments of God appears again as truth. It seems that, in non-recognition of it, man acts with a perversity little short of insanity, for the insane are those who irrationally endanger both others and themselves.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 15

Sind and Egypt

According to a famous saying, the greatest benefactor of mankind is he who makes two blades grow where formerly one grew. This is an especial motto of perennial irrigation.

This chapter is written mainly about a land where the largest or one of the largest schemes of perennial irrigation is in action, the province of Sind, India. The Lloyd or Sukkur Barrage, which controls this scheme, was opened in 1932.

The making of soils from the weathering of rock is a process which takes a very long time. The geologist, Mr. T. C. Chamberlin, in an address given at a Conference of the State Governors of the United States of America, held in 1908, wishing to impress upon his authoritative hearers the tremendous importance of the conservation of the soil, did so in the following words: 'We have no accurate measure of the rate of soil production. We know it is very slow. It varies with the kind of rock ... Without any pretensions to a close estimate, I should be unwilling to name a mean rate of soil formation greater than one foot in 10,000 years on the basis of observation since the glacial period. I suspect that if we could positively determine the time taken in the formation of the four feet of soil over our average domain, where such depth obtains, it would be found to be above rather than below 40,000 years. Under such an estimate, to preserve a good working depth, surface wastage should not exceed such a rate as one inch in a thousand years. If one chose to indulge in a more liberal estimate of the soil-forming rate, it will still appear, under any intelligent estimate, that surface wastage is a serious menace to the retention of our soils under our present management. Historical evidence enforces this danger. In the Orient there are large tracts almost absolutely bare of soil, on which stand ruins implying former flourishing populations. Other long-tilled land bears similar testimony. It must be noted that more than the loss of fertility is here menaced. It is the loss of the soil body itself, a loss almost beyond repair. When our soils are gone, we too must go, unless we shall find

some way to feed on raw rock, or its equivalent.'

This is a very succinct description of the final danger of unwise cultivation of stationary weathered soils. But the soil of the Indus Valley in the alluvial plain of Sind has not been formed from the rock beneath it. It is soil which has been formed at varying, and, mostly at great, distances. The greater part of the preliminary weathering has been done in the Himalaya, the Karakoram and the Hindu Kush Mountains. These mountains have crumbled under the action of frost, heat, ice, snow and rain, and the crumbled stuff has been carried by innumerable streams and rivers, uniting near the border of Sind into one great river some three hundred miles from the sea. The alluvial plain of Sind is the result of this river's annual floods.

Sind, therefore, has *not* to fear the dangers of surface wastage, of which Mr. Chamberlin spoke. Contributions to her soil have been made on a far more generous scale. To her the highest mountains of the world have paid their annual tribute for countless years, in the thin layer of silt, which is spread out by the flooding Indus. The soil of Sind is, therefore, very deep compared to weathered soils; in place of the four feet of weathered soil, of which Mr. Chamberlin spoke, there is as much as forty feet formed by waferlike sheets of mud.

Further, in contrast to stationary soils, there is not any sharp distinction between soil and subsoil. An alluvial soil, seen in the cutting of an embankment, is featureless, but it also lacks uniformity, for it is the result of a series of irregular floods carrying their silt hither and thither in no regimented way. The two soils, stationary and alluvial, are quite distinct. Here, then, there is ample opportunity for the objectivity of man -- different soils, different treatment. Or if subjective, here lies a trap -- different soils, similar treatment. Has man avoided the trap or has he let himself be caught in it? Let us see.

Let us here again quote Mr. T. C. Chamberlin, with his neat, succinct way of saying things: 'Some of the soluble substances ... formed at the base of soils are necessary plant foods, while some are harmful; but what is more to the point, all are harmful if too concentrated. There is need therefore that enough water pass through the forming soil, and on down to the ground-water and out through the under-drainage, to carry away the excess of these products. An essential part of the best adjustment is thus seen to lie in *a proper apportionment of the amount of water which goes through the soils*. If this be not enough, the plants will suffer from saline excess.'

I have myself been able to examine alluvial soil in Sind, not as an expert but as an humble observer. I have been able to observe it in a cutting ten feet deep, above which the surface was soaked by irrigation. After the surface-irrigation, the water sank through the whole ten feet and disappeared into the earth at the foot of the cutting.

Just at the edge of my cutting there grew a border of stunted grass and a low

ericaceous plant. Farther from the edge was the irrigated crop. When the irrigation ceased, the upper layers of soil, wetted by a transverse spreading of water, began to dry owing to sun and wind. Eventually the upper two or three feet became quite dry and when I scraped it powdered off as fine, pale sand. But below this dry surface the layers down to the foot of the cutting remained moist for months after a good soaking, as I discovered when I scooped out small tunnels into its interior. The lower layers, then, have a notable capacity of storing water and, with it, soluble plant foods.

The humble desert plants, the stunted grass and ericaceous shrub, knew this, for they sent slender roots straight through the upper dry layers down to the moist layers. Some of the roots traversed the whole ten feet of the cutting and disappeared into the earth at its foot. These astonishingly long, fine roots, in places where they are numerous, look like combed hair. They show quite clearly that they only rely for a short time upon the upper layers of the alluvial soil for their food and water. *It is upon the lower layers that they rely for their continued sustenance*.

The character of an upper dry, and lower moist, area after a soaking with water appears to be similar in all deep, river-made soils in arid climates, such as those of Sind, Egypt, Irak and the like. This character was described in 1906 by Professor Hilgard, as found by him in the San Joaquin Valley in California. He found also a third, dry, airy area, below the moist area, due to the soaking water pushing the air in the soil in front of it through smaller and smaller channels, until it could no longer bubble up. The compressed air in this third area prevents the further fall of water, except in cracks through which it finds its way to the ground water.

This third area not only holds up the water in the middle area and prevents further loss downwards, but it also supplies that area with oxygen, which helps the microbes in it to prepare soil-foods for the plants. The arrangement, in short, is a strikingly perfect one, as one might expect, for how else could vegetative life be possible in these climates? It is possible because of the storage of water and foods and air in the voluminous middle layers, which are themselves protected against evaporation by the upper dry layers. It is, indeed, just another example of the usual, that where there is life under unusual and difficult conditions, there will be found so appropriate and delicate an arrangement that men used to declare they saw in it the revelation of a higher intelligence.

And they might well in all reverence take that view now. Certainly when they separated out the acres of Sind for themselves under the Sukkur Barrage and Canals System, they placed their own intelligence in immediate relation to this higher intelligence. That the Sukkur System can be acclaimed great, there is no question. It is great. The making of it is indisputable testimony to great technical intelligence. But is the planning and execution also testimony to higher intelligence? Here one may hazard that, from the point of view of the soil itself, the lack of higher intelligence so characterizes the industrial age, that its existence in this planning would be exceptional. The Sukkur Barrage in its aims has not been exceptional. It has been

sponsored by modern, practical, money-making men, who have made such tragic blunders in the agricultural world elsewhere.

Nature's way of *soaking* these soils in arid countries is precisely the same as that by which she *forms* them, namely, by an *annual* overflow of the river. When men originally brought in irrigation to direct the overflow to their own advantage, they did so by putting embankments to enclose large areas or basins of flat land and then sending the water into them by water-channels. During the period of the flood, water passed on from higher basins to lower basins on the way to the sea, and in each basin silt was deposited. This form of irrigation is known as basin-irrigation. Its chief exponents have been the Egyptians. The waters of the Nile were enclosed in the embanked basins for fifty days or so, some movement occurring all the time as water passed from the higher to the lower basins, eventually to be drained back to the river. In that fifty days the soil of each basin got a continuous soaking and upon it a certain amount of rich silt settled. The soil of each basin was cropped each year and, after the harvest, was left uncropped until the next season of flood.

Now, if this method of irrigation is carefully considered it will be seen that it is an adaptation of the natural cycle of events to the Egyptians' use. The water lay upon the land for the same fifty days or so of the natural flood of the Nile and received the same deposit of mud. Throughout their long history, the Egyptians did not alter the natural cycle. It was only in the last half-century that perennial began substantially to replace basin irrigation, and the reason was that perennial irrigation permitted two crops in place of one. It earned, therefore, the blessing given to *those who make two blades grow in place of one*.

This advantage of perennial irrigation is brought about by a *permanent* high level of the river above a dam or barrage placed in its course. Main canals lead off the heightened water from above the dam and minor canals distribute it. It makes constant use of the artificial high level of the river, and, using the water that flows in the river all the year round, it is obviously not wasteful but conservative. But there is one daring thing about perennial irrigation; *it alters the age-long habit of river-made soils in arid countries*. What it is made to do is, in fact, to treat these arid soils as if they were soils dependent upon frequent rain, for by means of locks and gates there is a giving of water every ten to twenty days.

The system increases the products of the soil not only by putting more land more frequently into use, but also through more frequent crops it makes greater demands on the stored plant-foods; at the same time it does not cater for an annual settlement of silt as does the basin method. It gets its results by an exploitation of the alluvial plain and not by an application of its natural habit; thereby issuing as it were a challenge to nature. It might, therefore, call forth a retaliation from nature. Actually it does do so and the retaliation takes the form of an accumulation of salines in the soil. These alkaline salts lead to a deterioration of the soil and, when advanced, prevent the growth of crops altogether.

'The Egyptians, writes Mr. G. V. Jacks in *The Rape of the Earth*, during the long period in which they used basin irrigation, 'lived on the soil's income and won lasting security against natural hazards at the expense of progress. With the introduction of a more efficient technique into Egyptian agriculture, the soils have steadily deteriorated. "Soil alkali" has become a serious and growing menace, cotton yields are falling. The deterioration has been due in the main to the substitution of perennial for basin irrigation.' Basin irrigation suits the soil and is akin to it. Perennial irrigation, on the other hand, is not akin to it. But, at a time of the unchallenged dominance of money, the perennial form was unavoidable as 'a substitution indispensable for the cotton growing, by which Egypt has advanced and enriched itself' (Jacks). Nevertheless, in its very success, it has staged once more the drama of money versus the soil, with money in the role of victor. But nature will not be gainsaid. The very source of Egypt's life suffers, and though the present generations gain the future ones will lose. 'Egypt's advance to modern civilization is being bought with soil fertility,' is the conclusion of Mr. Jacks.

That great agricultural genius, the late Professor F. H. King, who became Chief of the Division of Soil Management, United States Department of Agriculture, in his book, *Irrigation and Drainage*, 1898, reflecting upon 'the fields of the Nile kept free from alkalis for thousands of years', and upon the present increase of salts 'to so serious an extent that many acres have been abandoned', was struck by the thought, which like a flash in the dark illumines the brain of genius, that these great irrigators must have *tried out* so obvious a modification of basin irrigation as is the perennial. 'The probabilities', he wrote, 'are that long long ago the more rational methods (?) now being practised had been tried and found inadequate or inapplicable, on account of the accumulation of alkalis which they permitted, and the old irrigators learnt to be content with a system which, although more wasteful in some ways, still kept the dread alkalis under control ... It is a noteworthy fact that the excessive development of alkalis in India, as well as in Egypt and California, are the results of irrigation practices, modern in their origin and modes, and instituted by people lacking in the traditions of the ancient irrigators, who had worked these lands for thousands of years before. The alkali lands of to-day, in their intense form, are of modern origin, due to practices which are evidently inadmissible, and which, in all probability, were known to be so by the peoples whom our modern civilization has supplanted.'

In India the adjacent provinces of the Punjab and Sind have both been widely developed by perennial irrigation, and both have reacted, even in a brief span of years, by increasing alkali. In *The Summary of Results*, published in 1940 by the Agricultural Department of the Punjab States, one reads: 'In the Punjab vast areas of alkali soils have come into existence.' In Sind there have been but a few years of perennial irrigation, for the Barrage was only opened in 1932. Nevertheless, in the 1937-8 Report of the Department of Agriculture, it is stated: 'This constant application of irrigation water, for raising crops in such intensity, has brought in complex soil problems, the solution of which is necessary to the success of the

projected agricultural progress of the Province ... Though precise information is not available, it is known that there are thousands of acres of *kalai* (the local name for alkali) land where no crops would grow. Besides these large stretches, there are scattered all over the Province, almost in every holding, small pieces of *kalai* land where crop either does not grow or grows very poorly.' Since the opening of the Barrage, as is above stated, precise information is not available. A few researches made, where it was possible to contrast pre-Barrage with post-Barrage conditions, show that the warning of Mr. T. F. Main, Director of Agriculture in 1929, that 'under perennial irrigation one must look forward to vast areas more or less infected with salt' is a prophecy likely to be fulfilled. Alkali is already the most urgent problem in Sind, and the most effective remedy that has been found, is, says the Report, to put large quantities of irrigation water, 16-32 inches, depending upon the salinity,' to soak the soil. In other words, *the most effective remedy is a temporary return to basin irrigation.*

When the soil is capricious and tends to deteriorate, more is involved than a diminution of crops. The whole life-cycle deteriorates too. In reading the Report one is impressed by the great amount of disease, not only of the soil, that there is in the Barrage area. It is true that at present no immediate linkage between disease and alkali has been investigated, but then nowhere is the relation of the soil to the disease of the life-cycle it supports properly recognized. It is not put in the foreground of official agricultural reports anywhere and only appears more or less by chance.

Cotton is the crop to which the Barrage System is particularly suited, yet in Sind this fluffy beauty is as delicate as a Brighton invalid. Here are some of its enemies and diseases: jassids, white ants, pink and spotted boll worm, black-headed cricket, dusky cotton bug, lucerne caterpillar, red pumpkin beetle, root rot, boll rot, red leaf. So it is officially stated: 'There is no doubt that the losses suffered annually by the cotton growers of Sind, on account of damage to their crops by insect pests or fungoid and bacterial diseases, are immense, and scientific research work on these pests and diseases is most urgently required.'

Re the animal phase of the cycle, the system was not designed for Sind's famous red cattle, as is evidenced by the fact that 'since the commencement of perennial irrigation, the yield and quality of the *jowar* crop in Sind have deteriorated in many tracts'. *Jowar* is a common food of cattle and with its deterioration 'there is a general deterioration in the breed'. A 'heavy toll' in animals is taken by such diseases as liver fluke, rinderpest, parasitic gastritis, haemorrhagic septicaemia, and so on.

Lastly comes the human phase. The chief disease, which affects the countrymen of Sind is malaria, and, *re* malaria, the Public Health Report of 1938 states: 'Its incidence has increased with the inauguration of the Lloyd Barrage and Canal Construction Scheme.' It is not possible to compile accurate statistics in rural Sind, but the prevalence of malaria is brought home to landowners, because its weakening effect on the labourers is produced when there is the greatest call for their labour. Some

harvesting actually has been abandoned because of the shortage malaria produces.

The increase of malaria is connected up with the System in the following way: the System brings more water; more water brings more pools; more pools bring more mosquitoes, and the bite of mosquitoes leads to the infection of malaria. But this quite possibly is not the whole story. The Sind soils tend to be alkaline, with, in the language of science, a pH of over 7. Low degrees of alkalinity can be neutralized by the carbonic acid which the roots secrete, but, if alkalinity increases, the water of the soil cannot hold iron and manganese to the same degree as it can when it is neutral, and these two are the chief metals of the red matter of the blood.

Under the Barrage System only a small investigation of pH values has been made, when it was found that the pH had risen from an average between 7 to 8.5 in pre-Barrage days to an average between 8 and 9.5 in post-Barrage. If this were generally true, then the plants in the post-Barrage period as eaten by the Sindhis would have less of the metals that form the strength of human blood. Malaria in particular, is due to parasites in the blood itself. The weaker blood favours the parasites of malaria and so malaria is increased for subtle reasons of the life-cycle and not merely from more pools and more mosquitoes.

Whether this sequence will be found or recognized to be a further example of how we humans must be thought of as part of a life-cycle or whether it is rejected, there can be no question that the growing of two blades where one grew in Sind has ushered in a cycle of sicker soil, sicker plants, sicker animals and sicker humans. Were there a definite measure of character and morals, it is possible that even now these would be found to have deteriorated. In the general opinion of those with knowledge of Sind, there has been a notable deterioration, but this is not attributed by them to a slackening of efficiency and authority under provincial self-government.

Mr. Jacks proclaims that alkali is not as dangerous as erosion, because it can be remedied. The most effective remedy in Sind and elsewhere is the soaking of the soil. Rice growing is also effective, for in the growing of rice, the soil is covered with water and thoroughly soaked. Both processes are of the nature of the basin irrigation, which in Egypt for so many centuries completely protected that wonderful land against alkali.

What will be the end in Sind? Will the stubbornness of nature and her dominion over all terrene life once again either force men to comprehend, or will it make their habitations barren? Is an old, old story in the East again to be repeated? Sind, like Egypt, is buying her way into a money-ruled civilization with her soil-fertility. Will the agricultural scientists, obedient not to the soil but to their urban masters, enable this money-dominance to hold its position against the affronted land? Will they, by their fragmented methods, be able to go further and establish a stable, healthy life-cycle in Sind? Will they fail?

For myself, I look for an answer to the man, who of all men seems to me to have had

the widest and wisest vision in these great matters, the late Professor F. H. King, and return to his words: 'The alkali lands of to-day, in their intense form, are of modern origin, due to practices which are evidently inadmissible, and which, in all probability, were known to be so by the people whom our modern civilization has supplanted.'

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 16

Fragmentation

When, in the first half of the industrial era, the call upon the soil for food and raw material became urgent, certain scientists set themselves to study the means by which the soil was enabled to create more life. They did not do this by a wide observation of nature in the forest, prairie or elsewhere, nor by a study of successful farming, past and present, but they did what is typical of scientists, they selected one aspect of the question and concentrated on it. They selected plant-food, not in its entirety, but in the fragmentary aspect of a particular character of it, its chemical character. They acted as simplicists, split off a part of a whole problem, and attempted by an intense study to make the part solve the whole. Thereby they eventually made the part greater than the whole. However, the story tells itself.

The men who set out to solve this problem, or, in other words, to put a scientific theory and practice of plant-feeding in the place of the traditional, observational knowledge and practice, were not farmers. They were chemists, allied, therefore, to the chemists who then were making factories so successful.

The three leading men in this venture of the human mind were Theodore de Saussure, Justus von Liebig and J. B. Lawes. Liebig (1803-73), with whose name the venture became chiefly connected, had already won a wide recognition as one of the greatest chemists of his time. In 1832 he, with Wöhler, published a memoir called *Researches on the Radical in Benzoic Acid*, in which he showed that the radical benzoyl might be regarded as forming an unchanging constituent of a long series of compounds. By this great work, he opened out a new era of organic chemistry, and made possible the elucidation of the numberless combinations of a few elements, such as those which figured in Chapter 14.

It was, therefore, with a great prestige and unavoidable recognition on his part of his own pre-eminence as a chemist, that in 1838 he turned his powers to a subject that

was urgent and immediate, the subject of the production of more food. It was a time known in England as the 'Hungry Forties' and in Germany one of grave social unrest amongst the growing industrial population. Liebig became drawn to the nature of food, vegetable and animal, and such was his forceful intelligence that he was sure to make out a very strong case for the chemist with regard to it. He did so. In this vital matter, he made out the claim that the chemist should be the supreme arbiter.

He rejected the farmers' knowledge that the plants derived their chief nourishment from humus, formed by the decay of dead animal and vegetable matter. He taught that plants took their nitrogen and carbon from the air and eventually returned them to the air by the agencies of putrefaction and fermentation. There was no loss of either carbon or nitrogen in this cycle. But it was a different matter with the minerals that plants required, such as phosphorus, potash, soda, sulphur and lime. These came from the superficial earth, in which they were limited and could become exhausted. What the farmers had to do was to make good the loss by giving back the required amount to the soil. To affect this, they had to put themselves in the hands of the chemists. The chemists would take some of the crops to the laboratory and there burn away the organic matter and analyse the minerals of the ash that was left. They would, then, discover whether phosphates, potash, sulphates, lime, and also nitrates since nitrogen was not supplied speedily enough by the air, were defective in quantity. By mining the deficient salts or by manufacturing them in factories, they would supply those that were required. The ones particularly required were grouped under nitrogen, phosphorus and potash, with lime which had long been given to fields in the form of marl or chalk. These chemicals became known by the term of 'artificial' manures in contrast to natural, farmyard manures.

At no time could circumstances have been more favourable to artificials than at the time of their introduction. The overthrow of the conception of men's partnership with the soil, which is embodied in a free peasantry, had been completed as has already been told. The old feeling for the land as something living and creative had disappeared with the peasantry. The land had become something to be owned and worked for money. Large, new populations were awaiting food and also other raw materials of plant growth. Fortunes were won through ownership of land as quickly as through that of factories. The land of England had, therefore, been seized by wealthy and ambitious men, and the peasants had been turned off their holdings and their commons. The peasants were subjugated by the rich, as if they were a conquered people and not fellow-countrymen.

Urban areas, too, were rapidly ceasing to have the character of country-towns and were differentiating themselves as almost purely industrial. The leading industrialists, on their part, had also defeated the countryside. They had destroyed the rural cottage industries and thereby had forced the young and able-bodied country folk to serve their factories. Whether on the land or in factories and mines, the new order was rich men and, completely subservient to them, the proletarians. This was the rural condition which constituted the parentage of 'artificials', and, from the point of view of life-cycles, it was bad.

On the other hand, it may be claimed that these chemical fertilizers made a big contribution to the difficulty of feeding the new, urban populations. Apart from exceptional farmers, the soil had for long been indifferently manured. The elements which artificials supplied were needed, and larger crops followed their use. Healthier and better results could have been effected by the systematized collection of great quantities of urban and rural waste and the manufacture of it into manure. But there were difficulties. Firstly, the roads were bad. Even the best of roads were such that royalty sometimes could not get from Kensington Palace to Richmond owing to the mud. If this were so where royalty passed, collection and distribution of stuff needed by farms and villages were not likely to be systematized, a word that did not apply to the farming of that day. Secondly, the making of manure from wastes requires planning and labour, and there was a lack of both in the English countryside.

Artificials had many advantages over natural manure. They were either mined or manufactured. They were much less bulky to transport, and they were very easy to spread upon the fields. They were, indeed, almost too practical and convenient; they offered the allurement of ease, and, as they gave quick results, landowners and large farmers were satisfied. Science thus came to the rescue and scored a triumph. Artificials did great service in a period when the altogether unprecedented increase of population and new towns enforced an exploitation of the soil in a country of backward agriculture. They provided a partial and artificial fulfilment of the rule of return. They singled out the most important elements of plant food and replaced them, even if distant islands had to be sought to get the required substance. This feeding to the land was certainly superior in its results to no feeding at all. It was planned and conducted under skilled guidance. It increased yields, strengthened weakling crops in their growth, filled in gaps when the introduction of motors and tractors led to losses of organic manure by displacing horses and oxen. In consequence, artificials came to be used in large quantities in many parts of the world.

Nevertheless, they were and they remain fragmentary; they are not a full return of all that is taken from the soil. Is there evidence that in results they have not had a whole effect, such as their partial character would indicate? At the very outset there is something which, in a sense, is so fantastic and yet so in keeping with the spirit of that exuberant time, when the first burst of wonder was aroused by the many triumphs of the scientific method, that it seems almost logical. It is this: *the life-cycle was not used as a test of artificials*.

There is the justly famous small plot of ground of Broadbalk, Rothamsted, the experimental station founded by Mr. J. B. Lawes, where for a century wheat has been grown yearly on soil with a full complement of artificials next to a similar plot, where farmyard manure has been used. The wheat on both plots looks well and yields well. But all tests of this century of experiment have stopped with the crop itself and its quantity. The crop has been watched as a thing in itself by the close, careful, fragmentary , watch of science. It has just been a market test, the quantity of wheat

yielded by a plot of such a size. No animal phase of the wheat as a food has been tested, nor has its vegetable factor been complete, *for the seed of the plots has been imported from outside*, bringing in qualities of life-cycles not belonging to the plot. So the whole century-old experiment has been without any life-cycle tests, *has indeed belonged to no life-cycle. It has been individualized, separated, specialized. But in nature nothing is like that.*

This fragmentary method in agriculture, as elsewhere, became the standardized method of test. It has not, even now, reached the stage of the life-cycle, in which observant peasants and the health of themselves and their products enter as a part of it. Scientists, it is true, do test out crops and foods on animals, but in a fragmentary and apparently inexhaustible manner, and, except the estate planned by Lady Eve Balfour in Suffolk before the outbreak of war, there was in Britain no experimental farm, in which the life-cycle was the standard of test.

There seems to be, then, only one way to get an answer to the life-cycle results of artificials and that is to take a general view of the results of agriculture in the period, in which artificials have played a prominent part.

Firstly, we will take quality as denoted by taste. That great farmer, Mr. F. A. Secrett, at the Royal Society of Arts in 1935, spoke of taste and quality in this practical manner: 'I notice that in Covent Garden and the larger provincial markets, those stands are favoured where the produce has come from farms which have received organic manure. Although higher prices are charged for this produce, it is sold out first.'

Taste and choice are, of course, natural measures of food, but they are not scientific ones. People are so subject to the statements 'proved scientifically', 'measured scientifically', that they fail to realize that the excellencies are not measurable and therefore have to be disregarded by science. The customer, who likes the look of a basket of gooseberries and takes one to taste, is a sound measurer, but he is not a scientist. A scientist, as scientist, cannot measure appearance and taste. (A very great and honest scientist, Charles Darwin, said that his work had spoiled his appreciation of music.) But people can still judge by taste, and it has been noted by those who grow vegetables and fruits upon land where full return is practised, that customers give a sudden expression of surprised delight when they first bite into these products. They have come to expect almost a savourlessness in market-garden produce. Anyone who has tried out foods grown from full return and those from artificials, immediately recognizes the distinction. One is inviting, the other insipid. Market-gardeners themselves know it, but now that motor-cars and vans have driven out the huge horse population which once belonged to the towns the gardeners served, they have been left mostly helpless. Animals, too, know that taste is a safe guide to good food. Mice have been tried out by giving them two troughs, the one filled with grain grown by the bio-dynamic methods, which is a 'whole' method, and one with grain grown by artificials. The mice invariably chose the first trough and finished its grain before they

went to the second. Similarly cattle, let into a field equally divided into 'artificials' and 'whole return' areas, collect and graze upon the whole return.

Nevertheless, in searching around it is surprising how few are the examples of choice. The curious fact emerges that *the taste of fresh foods is no longer regarded as a guide*. The great majority of modern foods are scarcely expected to taste of themselves by the mass of their consumers. Tastes, as condiments, sauces, curries,, and so on, have to be added to them.

The next test of quality is health. Can it be said that the products are healthy under modern farming, in which artificials have come to play a dominant part?

To answer this question by personal observation, one would have to go on a tour like those of Arthur Young, William Cobbett and Rider Haggard, and see for oneself. We have to find a less laborious journey, and this is readily achieved by going through a textbook on modern farming, which gives one, as it were, a guidebook to a country one does not know. As the majority of people do not know the farming world, such a book will form a guide to what is to the reader virtually a foreign country. I have such a book before me, written with the excellent technical skill which one expects in such instructive books. I have read through it several times, with the spirit of a traveller seeking to know what this new farming world is like, and each time I have wondered the more at what I read.

There is first the soil. In this new country one soon comes to realize that the soil is not a bit like the soil in nature, a part of a general life-cycle. It is *a thing in itself*, the composition of which is understood by scientists as something that they can manipulate, compound into its several parts and dispense to farmers as compounders dispense medicines. What the soil did in the past and still does where left to nature, what it did under the cultivation of past farmers, these are things of the Dark Ages before the light of modern science came to the world. As principles or assistants to knowledge, they are not even mentioned. Previous knowledge and tradition of the land are treated as the previous knowledge of, say, radiology and wireless, as not worth mentioning. But the soil is something very different to new scientific subjects or discoveries in technique such as that of Marconi. The scientists, however, seem to see no difference between technique and vitality.

The manipulated soil gets a number of diseases, so the wise modern farmer will get his soil overhauled by a soil-scientist, as the townsman gets himself overhauled by his local doctor. But with these numerous complaints and their treatments we will not deal. The spontaneity of the soil, by which it has done its job of life-supporting for endless vistas of time, is lost in this new country. So, even though one knows the language, one has also to know the exact meaning the scientist gives to his words. One wonders what exactly he thinks of the soil. Is it a vigorous re-creator of life or a cantankerous invalid? Is it the peasant's partner or the scientist's patient? It is really confusing, but let us go on with our journey.

We now enter another province, that at which the scientist is at his happiest technically, manipulating the breeding of plants and animals in ways so quietly discovered by the monk, Mendel. In this province, wonderful varieties of life have been fashioned. Here, for example, are pigs so fat that to their progenitors they would appear nightmares rather than pigs. They have been conjured into masses of streaky bacon such as a public has been taught especially to value. Sometimes the public taste in bacon is changed, and with it the pigs are changed, the scientists being able to switch their fat and lean about so as to make a change practical. These pigs are bred, fed in special ways, stalled and slaughtered, and often never go under the open sky, until they are taken to the market. They are, of course, delicate, but they are bulky. They are tasty, too, when they reach the table, so that here public taste itself seems faulty as a guide, and this would be so, were it not that the taste is directed not so much by the consumers as by the retailers.

Still they are tasty, especially to those who have not or care not for the powerful crunch of orthodontic teeth.

Here, too, are cows specially bred for milk. They also see very little of the open sky during their useful life. They become mothers and their udders fill with milk. Their calves are almost at once taken from them and the mothers are transferred for service to long and very clean buildings near large towns, where each one has her stall. Antiseptic chemicals are requisitioned to cleanse the teats of microbes and then a machine is attached to the teats, which sucks out the milk into sterile receptacles. Extreme watchfulness and care is taken. Above all the scientists have to test and examine for tuberculosis, for there is probably no group of living animals so prone to a grave infection as are these unnatural cows to tuberculosis. I have not with me nor can I recall the percentage of cows in Britain that have tuberculosis, but it is surprisingly large. Our guide to this new farming country, however, comes to our assistance. The best way of preventing the spread of tuberculosis in dairy herds, it says, is to test the cows by the tuberculin test and to destroy those with a positive reaction. The objection to this practical man's treatment of an invited disease is that it means a capital loss to farmers, which they cannot afford. The scheme, though declared to be *scientifically sound*, is not carried out in practice. It is a good example of the language of this new country being so topsy turvy as to distort the meaning of words. *Sound may be so allied with science, but it certainly cannot be so allied with nature. To be sound in nature is to be healthy.*

We have now had a sight of some of the animals in the new country. We will direct ourselves to some of its crops. It does not really matter which crops we choose. We will, therefore, select two of the commonest forms of human food, wheat and potatoes.

What is wanted is a wheat of the best quality. There we all agree, but the word quality in the new country has a different meaning to that which it had in the old one, when it

meant a wheat that gave a health-giving and tasty loaf. Quality is now milling quality, the capacity to make large loaves. Imported wheat is better quality in this respect than British wheat, for a two-pound British loaf is only two-thirds as big as a two-pound loaf of imported flour. For this reason the British flour is called weak and the imported strong.

The science of plant-breeding is recent; it belongs to the present century, and one of its early triumphs was in the making of British wheat strong. This was accomplished by breeding on Mendel's principles. 'Yeoman' and other wheats show that strong wheat could be grown in Britain. But, though these wheats were strong in the baker's sense of the word, they were not strong in health. They were, like the so-called soft wheats, subject to many diseases, of which certain 'rusts' are particularly destructive. A wheat, called 'Ghurka', was fetched from Russia because it resists rust and it was bred with British wheats, and finally there emerged 'Little Joss', which was immune to Yellow Rust. Its baker-quality was not so good as that of 'Yeoman', but its health was better; so by better health it lost one quality in gaining another.

There are many other diseases of wheat; there is, for instance, one with the unpleasant name of stinking smut. To avoid stinking smut the seeds of wheat before sowing are soaked or dusted with chemical antiseptics, so strong that those who handle the seed have to guard themselves against being poisoned. Some of the poisons were too dangerous for common use, so the scientists set to work to find safer poisons. Coated with these poisons, wheats of good quality can emerge into life.

Now those who can remember the cottage loaf, as made by hand in the countryside before these changes were begun, will recall the delicious flavour of the bread. But a delicious flavour is not a measure in this new country. See, for example, what has been done with our second choice, the potato. The potato is an American plant with its original home in Peru, when that country was itself the home of a very great agricultural civilization. Our guide to the new country, however, tells us what a poor-quality thing the potato was before being taken in hand by the scientists. Potatoes of the present day, the guide-book, declares, are much superior to the small 'highly flavoured' potato of the last century. Nowadays a hygienic public, trained to associate the colour white with cleanliness, demand what in the new country is a quality-potato. It must be of medium size, thin-skinned, with few eyes, and above all, it must be white. It must have a 'good' appearance, it must be a 'shop-window' potato, though its flavour is poor compared to its yellow-fleshed, highly-flavoured and more nutritious ancestor. But this yellow colour is not 'quality'; it is, a 'discoloration'; merchants will not buy such potatoes and the public will not eat them. How is it that the public rejected flavour and nutritiousness in favour of bulk and appearance? Is the answer not clear to my readers? Bulk, if it means ultimately less to the consumer, means more gain to the seller. Money scores. And appearance, is that not a second falsity of money, the eye displacing the tongue, where the tongue should serve the whole in the supreme matter of vitality? Or, to discard the serious for the humorous, how many times have I not read and laughed at Alice in the Looking-Glass, until, following my guide-book, I realized that I too was living in such a wrong-way-round

country.

Of course the potato has a number of diseases. We read of them, in the guide-book. It is really delicate, so delicate in fact that in many countries, including Britain, certificates are issued by special inspectors that seed-potatoes are free of virus, and, in consequence, that their offspring will not be killed out to an extent of more than 50 per cent by virus diseases. There are, of course, fungus diseases as well. There is, for example, wart disease, which is so dangerous that in 1923, Government made its occurrence notifiable to the police.

So one travels in the new country, to hear the same tale again and again repeated. Finally the traveller comes to the opinion that *the modern scientific farm, and especially the experimental farm, is a mixture of forcing house and hospital*. It fragments the life-cycle. It is the offspring of a defect of thought, the splitting or departmentalizing of the mind, which disables it from seeing wholeness and that men, animals, plants and soil are inseparably united.

Under this fragmentation, insects and other pests have assumed a dominion, which assuredly they have not got in nature, frit flies, aphides, moths, cut worms, wireworms, leather-jackets, warble flies, maggot flies and the rest. But, through these misfortunes of the new farming, the balance of nature is once again emerging under the term ecology. How different is the tale of ecologists to that of scientific money-farms. Here is the evidence of one of them, taken from the Bio-dynamic Agricultural News Sheet of April 1938:

'We have found it possible to prevent the plants from suffering damage from insects simply by means of suitable biological measures, and without taking steps to kill them. In vegetable culture proper we have mostly to do with plants whose flowering impulse is held back, as, for example, all kinds of cabbage, carrots, radish, chicory, leek, celery, beetroot, turnip, etc. Or we have to do with plants whose flowers are not very prominent, such as beans, tomatoes and similar plants. From this repressed impulse to bloom there results a certain one-sidedness. True flowering plants are not amongst them. A close study of the relationships in nature makes it clear that the insect and plant worlds are complementary to and dependent upon one another, and moreover that certain insects and certain plants are sympathetic to each other. Vegetables enable insects to develop their larvae and flowers offer food to countless fully-developed insects. And there are many small creatures which prey on each other, such as the spiders, ichneumon-fly, ladybirds, etc. If we provide as large a variety of insects as possible with the means of living, most of them will in time live harmoniously together, and the harm done by this or that one will be practically negligible. That is why it is so important to have flowering plants near vegetables. The aromatic herbs are especially valuable for this purpose, e.g. borage, lavender, hyssop, sage, thyme, marjoram, dill and fennel ...

'At first the grubs of the cabbage-fly were very destructive. Now we do not mind them

at all. If on, warm days, at the end of April or May, the fly lays her eggs on the cabbage plant, the red mites find them and suck the eggs before the larvae emerge. There are many such compensatory adjustments. The sand-fly drags many caterpillars away to bury them for its larvae. In springtime ants seek among grass and plants for the larvae of the daddy-long-legs and kill them. Even the wireworm made itself useful by preferring pre-digested plant-stuff and destroying the larvae of a cabbage-fly.

'Not only do insects balance amongst themselves, but toads, frogs, moles, shrew-mice and lizards take part in this adjustment.'

Men, animals, plants and the soil are balanced and united. That is the clear meaning of the above close observer and follower of nature. It is the answer to all that strange, new country, through which we have travelled. It is also the answer to that particular part of it called 'artificials'. Men separate and fragment. They separate a science from nature as chemistry. Then the common thing, which bad thought permits, happens. The new specialists, the chemists, look at the vital processes chemically and lay claim to be its guides and masters. Being scientists they get the support of other scientists, and that of the scientific method, the method of experiments, which can be repeated by any properly trained individuals. Thereby they fragment, isolate and simplify questions, and make them readily 'comprehensible' and 'controlled'. By 'artificials' not only do they reduce the feeding of the soil to a purely chemical process, not only do they omit the secrecy, delicacy and variety of nature's own methods, but they limit the very chemistry itself. They fragment and simplify it to three or four minerals, those of nitrogen, phosphorus, potassium and calcium. But there are more minerals in the soil than are dreamt of in their philosophy; for example, those that accompany the growth of sugar-beet by the sea constitute, as Dr. Pfeiffer calls it in *Bio-dynamic Farming*, 1938, a 'small pharmacy of sodium, lithium, manganese, titanium, vanadium, strontium, caesium, copper, rubidium', some of which elements are as rare as their names are beautiful.

As to these rare and common metals, do we know what tone and quality we miss, if we lack our share of them? We already know from Chapter 14 of grave defects from small omissions, but the mind need not get confused contemplating their possibilities. We have just read of the wonderful balance of nature's adjustment between insects, flowers and other small forms of life. Will not nature effect the same balance within us, if she is allowed her way, and we follow and do not fragment her method of life-cycles? Will not each element harmonize with the others and so express health? How then can we expect health, when that harmony is broken in the soil itself? That is the answer to 'artificials'.

I could give other answers and show how, when the whole is followed, health must necessarily accompany it, but I will not do so, as I have already made this the subject of my book, *The Wheel of Health* (1938). But I prefer to end this chapter not with minerals but men. The intelligence department of our agriculture is wrongly based; it is an intelligence largely directed to cure the evils which it itself brings into being. It

is the countrymen's wisdom we need now, that of the countrymen who have built up long-lasting agriculture and whose wisdom lies in tradition. They have fashioned it by muscular and bodily work and by a close and immediate observation, by a personal intimacy with nature, which we have come to associate with the poet. And, in fact, peasantries are poetical and are so because of this intimacy. The music, dances and songs of the peasantries are *characteristic* of their countries; they are the creative expression of their own lives. Nothing collective or characteristic, as their life is, originates from people separated from the soil as are townfolk. The poems and essays that played a notable part in the country life of the Chinese, the Tibetan art which finds its way into every home, the sylvan setting of the modern Japanese villages, of the Balinese and Burmese, the vocal harmony of Swiss peasants returning from their fields, the reproduction of floral beauty and colour in festive dress of so many countries, these betoken the unvoiced poet that lies in every peasant's heart. It is this intimacy that becomes creative in the poet, as the great Greek people recognized in their use of their word poet, namely, a 'maker' or creator, and which Dante voiced in the *Divine Comedy*, when he declared that the poet was not the disciple of the imagination, but he who knows the secrets of nature.

It is this intimacy which reveals to the cultureless or self-cultured countrymen the complete, inter-dependent character of all the varying forms of life, and the health, goodness and beauty which come from it. Its all-pervading quality is something known by being seen, felt, lived with and realized, and not told to the ear. It constitutes that mystical unity, about which all the most meditative religious thought and all the most sublime art have gathered. The most famous temples of the world, the noblest poems, the loveliest pictures, the most transcendent music, have acclaimed it. They are all works of balance and beauty, created by the unity of realization on the part of artists, who know the secrets of nature. It is to their company that the knowledge and arts of the peasantries belong. They are, both great and humble, of like origin. But modern, urban civilization, split off from the creative power of the soil, has forsworn this great heritage. In its place there has spread a nihilism that year by year has been destroying art, truth and beauty, and, at the same time, in an immeasurable degree, the soil itself, to be consummated in a holocaust of men and nations.

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by G.T. Wrench

Chapter 17

East and West Indies

The Dutch began their career as empire-makers in the East almost at the same time as the British, the British actually having the small start of ten years. Both peoples came to the East to trade and both became imperialists almost as an accident of their being traders. But there was a notable difference between the two peoples, close neighbours though they were in Europe. It lay in their attitude to their own soils, and this difference they carried with them to their eastern possessions.

The consequence was that the Dutch, in their island government, left the cultivation of the acquired lands to the native cultivators, without interference other than that of the payment of taxes in kind, by which they got the tropical products they needed for sale in the markets of Europe. All that was concerned with the native agriculture, subsistence farming, the village system, and native rule, were left undisturbed. It was a method of rule, like to that which the British now follow in some of their West African Colonies and which that great colonial statesman, Lord Lugard, described as *The Dual Mandate*.

In the latter part of the last century, the Dutch Government of the islands gave up acting itself as trader. But it had become so firmly convinced of the value of the Javanese and other peasantries, that it protected them by the absolute prohibition of the sale and purchase of land.

Mr. Boys, of the Bengal Civil Service, visited Java in 1892, and he summed up the preservation of the Javanese peasantry in this remarkable passage: 'The Javans have escaped the fatal gift of proprietary right, which has been the ruin of so many tens of thousands of our peasantry in India, and with which, while striving to bless, we have so effectually cursed the soil of India. It is not too much to say that the many benefits which would have been conferred on Java by the substitution of the English for the Dutch rule, were not too high a price to escape from the many evils of the

unrestrained power to alienate private property. Under their present Government, the Javans according to our English ideas ought to be the most miserable people. That they are not so, but that, on the contrary, they are the most prosperous of Oriental peasantry, is mainly due to one cause -- the inability of the Javan to raise a single florin on the security of his fields, and the protection thus gained against the moneylender and himself. Nature is bountiful in Java, and undoubtedly the abundant fertility of the soil enables the Javan to stand up against many ills to which he is subject; but were her fecundity doubled, were she able to pour her gifts as from a cornucopia into his lap, nothing would ultimately save him from the moneylender and from the consequent eviction from his fields and his home, if he were able to pledge the one or the other as a security for an advance.'

The Javans carry out a very skilled peasant-agriculture and 'have got erosion under as complete control as has been achieved anywhere in the world,' writes Mr. G. V. Jacks, and continues: 'The Dutch Government in Java has carefully preserved and encouraged native anti-erosion agriculture, and the same principles are applied to European-controlled estates. There are no social barriers between European and natives in Java. The primary object of agriculture is to feed the people; the food supply of the community as a whole must be maintained on a permanent and secure basis before rubber, tobacco, coffee, etc., can be produced for export.'

Here, in this island picture, everything has been favourable to the soil. The traditional cultivation and anti-erosion measures of the Javanese are excellent; the early Dutch Government, as trader, was able to get what it required through taxes in kind without other interference; with knowledge, the Government came to value the peasants' skill so highly that it did everything to support it. And, in order to support it, the Dutch encouraged a rightly ordered agriculture, *the primary object of which was to feed the people*. By the absence of social barriers, both peoples, Dutch and Javans, were able to base themselves on the soil. By both the soil is, one can say, *vitally* valued. In Java, writes Mr. Jacks, they 'give every acre of land a national value that may be out of all proportion to its money-making power'.

This high valuation of the soil was indigenous. But one can well understand how highly it itself was appreciated by such a people as the Dutch. When they came to Java, the Dutch were themselves the best cultivators in Europe. But they were something in addition. Of all peoples in Europe, they had waged the greatest and most unceasing fight for the preservation of the soil; they, above all people had given land a national value. They had for centuries won land from the sea and flood and guarded it by dykes, which were their perpetual care. In knowledge of the use of water and drainage, in the rotation of crops, in the use of clover, in the full art of cultivation, the Dutch invaders in the Indies were greatly the superiors of their British contemporaries. The very improvements in agriculture in England, which were first adumbrated at the time of Elizabeth, were due to Dutch and Flemish influence and infiltration. It was Charles the First who brought Dutch experts in dyke and drainage to make his estate of the Isle of Axholme the best worked in England. Of all Western

peoples, therefore, appreciatively to take over Java and its sister-islands -- if such were destined to occur -- none could have been better chosen than these skilled and soil-revering farmers of north-western Europe.

So, in this respect, the Dutch East Indian islands had the advantage over the British West Indian Islands. Of the quality of the Eastern cultivators themselves, there is no better account than that of Mr. C. R. Wallace in his famous book *The Malay Archipelago*, firstly, because he was a great observer, and secondly, because he visited the islands seventy years ago and, in the island to be described, saw its agriculture as something entirely its own. It was a most felicitous combination of observer and observed. The resulting almost paradisical picture is one of enthusiasm, but at the same time of unexaggerated verity. The island is that of Lombock, separated from Java by the island of Bali. It has at present some 600,000 inhabitants. Its capital is Mataram.

'Soon after passing Mataram', wrote Mr. Wallace, 'the country began gradually to rise in gentle undulations, swelling occasionally into low hills towards the two mountainous tracts in the northern and southern parts of the island. It was now that I first obtained an adequate idea of one of the most wonderful systems of cultivation in the world, equalling all that is related of Chinese industry, and as far as I know surpassing in the labour bestowed upon it any tract of equal extent in the most civilized countries of Europe. I rode through this strange garden utterly amazed, and hardly able to realize the fact, that in this remote and little-known island, from which all Europeans except a few traders are jealously excluded, many hundreds of square miles of irregularly undulating country has been so skilfully terraced and levelled, and so permeated by artificial channels, that every portion of it can be irrigated and dried at pleasure. According as the slope of the ground is more or less rapid, each terraced plot consists in some places of many acres, in others of a few square yards. We saw them in every state of cultivation; some in stubble, some being ploughed, some with rice crops in various stages of growth. Here were luxuriant patches of tobacco; there, cucumbers, sweet potatoes, yams, beans or Indian corn, varied the scene. In some places the ditches were dry, in others little streams crossed our road and were distributed over lands about to be sown or planted. The banks which bordered every terrace rose regularly in horizontal lines above each other, sometimes rounding an abrupt knoll and looking like a fortification, or sweeping round some deep hollow and forming on a gigantic scale the seats of an amphitheatre. Every brook and rivulet had been diverted from its bed, and instead of flowing along the lowest ground were to be found crossing our road half-way up an ascent, yet bordered by ancient trees and moss-grown stones so as to have all the appearance of a natural channel, and bearing testimony to the remote period at which the work has been done. As we advanced farther into the country, the scene was diversified by abrupt rocky hills, by steep ravines, and by clumps of bamboos and palm trees near houses and villages; while in the distance the fine range of mountains of which Lombock peak, eight thousand feet high, is the culminating point, formed a fit background to a view scarcely to be surpassed in human interest or picturesque beauty.'

This great naturalist and observer, it will be noted, is struck by 'one of the most wonderful systems of cultivation in the world'; 'in a remote and little-known island, from which all Europeans except a few traders are jealously excluded'; a cultivation due to assiduous labour; a skilled and complete use of water including every rivulet and brook; the roads themselves are made subject to the water channels; the levelling of every plot of land, large and small, so that the water could be equally distributed; and he is able to end his description with a true and happy association of 'picturesque beauty' and 'human interest'.

The British in the West Indies met with no great indigenous cultivators like those of Java, Bali and Lombock. The British pioneer invaders of the West Indian Islands were themselves men of adventure. They were buccaneers, the bold buccaneers, who at their own personal risk and for their own personal gain set out upon the high seas to dispute the Pope's fiat that the New World, known and unknown, belonged to the Spanish King. They and the French took many of the islands from the Spaniards, and made them their own.

The early history of Jamaica is typical of these happenings. The island was discovered by Columbus in 1494, and taken over by the Spaniards. With a criminality towards indigenous peoples, which seems to have been peculiarly their own, the Spaniards annihilated its gentle and peaceful inhabitants. When the British took the island from them, the total of Spanish masters and their slaves did not exceed three thousand. So the British, who had left their homeland for love of adventure, and others who had left for fear of the law, now found fortune before them. In 1672 the Royal African Company was formed and Jamaica became one of the busiest slave marts of the New World. The cultivation of sugar was then introduced. Pepper, coffee, cocoa, ginger and indigo, products sent from Java to Holland by the Dutch, were now sent from Jamaica to Britain. When slavery was abolished in 1838, the prosperity ofJamaica was at its zenith.

In Java, as we have seen, the management of trade was undertaken by the Government itself, and the work was carried out by the people on their traditional lines. In Jamaica, the work was carried out by Negro slaves owned by planters, whose object was to enrich themselves, with or without the enrichment of partners in Britain. Though buccaneers no longer, the personal motive of the buccaneer remained with them, namely, that of using their property primarily for their own personal advantage. Soil and labour were both their slaves.

But slavery, while it endured, carried with it the obligation of the planter to feed and house his slaves upon the estate. So, the first function of the soil, to feed the people who work upon it, was fulfilled. There was a direct relationship between the workers and the soil upon which they worked. The planters, as slave-owners, had also a direct relation with their workers, a position that in the case of many of them, possessing the innate moderation and humanity of the British, amounted to a guardian, paternal chieftainship. They stood in a parental relationship, such as is so movingly described

in a recent best-seller, the novel *Gone with the Wind*, a relationship which, indeed, in its wide dimensions, has constituted the main human binding power of the British Empire, and which acted as a drag-anchor to the endangering selfishness of the increasing money-power.

'Slavery', writes Mr. W. M. Macmillan, in his *Warning from the West Indies*, 1936, 'was not, as some maintain, wholly evil in its effect on the slave-owner's character. It not only fostered a proprietary sense of responsibility; slaves made possible a spacious leisure ... Many fine planters in the West Indies and the Southern States, like some Cape farmers, have a delicacy of culture associated only with the choicest traditions of old Europe.' Such culture made good masters. The prosperity of the planters overflowed in a generosity to their dependants. One may say that, in terms of happiness, the West Indies were well off in the eighteenth century.

Anomalous as it may seem, the change was brought about by the emancipation of the slaves in 1838. This emancipation was an act of liberalism. But there is something greater than liberalism, and that is soil-wisdom. And in the light of soil-wisdom, this emancipation was superficial and unreal ... It was an apparent release of the slaves from compulsion; it was no less a release of the planter from certain responsibilities. The overruling factor in an agricultural island is not slavery or freedom, but direct subsistence-farming and craftsmanship for the peasants, their families and their kinsfolk.

And it is because of this that there are only two human relations of agricultural workers to the soil. The first is that of slaves, when they are assured of their subsistence from the soil and are valued by their owners and kept in health and happiness, because the estates are then well-worked and conserved and the human feelings of the family-owners give to the estates the quality of a home. A certain easy and ready acceptance of life, with the rich flavour of a landed aristocracy, comes into being, and places the whole art of life on a plane which stands above that of land as a mere agency for the market and for profit. The buccaneer becomes a gentleman and the slave a devotee.

Nevertheless, the money-purpose will become paramount, when the freedom and wealth of the landed gentry becomes shackled by the middlemen of the town. Money takes command. Moreover, the highly skilled, soil-conserving agriculture is not acquired by slaves, because they have not the sense of property. The meticulous care of the soil, which is required for it, seems to be the possession only of the second form of a human relationship of agriculture, that of the peasant-family ownership. The self-dependence of free peasants produces qualities of a grade necessarily superior to those of slaves.

The emancipation of slaves converts them into supposedly and so-called free, individual labourers. This change presented itself upon the West Indian arena in 1838. It has existed now a hundred years and recently celebrated its centenary. This it did,

logically enough as we shall see, by riots and revolts.

Mr. Harold Stannard, in *The Times* in 1938, described the dwellings of the humble agrarians in Jamaica: 'The first time I saw one of these hovels, I could hardly believe that it was intended for human habitation. Strands of dried bamboo are woven round a framework of stakes and the "room" thus formed is covered with palm thatch. There is no furniture except sacking on the earth and some sort of table for the oil-stove ... Urban conditions are, if anything, worse.' Royal Commissioners declared the slums of Port of Spain, Trinidad, to be 'indescribable in their lack of elementary needs of decency'. Conditions of labour sometimes find the Commissioners equally wordless: 'It would be hardly possible to find terms strong enough' to express their disapproval. The expression is but a part of the general chorus, which accompanies the imperial achievements of the time and which finds its full harmony in Royal Commission reports on labour in India, Basutoland and elsewhere.

Here is Mr. Stannard's statement with regard to nutrition and subsistence, the primary test of a right of property in the soil: 'Under the stimulus of a circular dispatch from the Colonial Office, inquiries have been conducted in the islands and have yielded disquieting results. Even to a non-medical eye the frequency of bad teeth among a population whose diet could and should contain a large proportion of fresh fruit and vegetables, gives cause for misgiving. Indeed, it is not necessary to look into the islanders' mouths. It is enough to glance inside the shops where they buy their food. Every Chinese-kept store exhibits, from floor to ceiling, shelf after shelf of tinned goods. These superbly productive islands, living mostly by the export of food, cannot feed themselves. It is estimated that Trinidad imports four-fifths of what it eats.'

This, then, is the condition of the islands, which Britain cherishes as the oldest of her colonies. Throughout their career of 'freedom', *she has never adopted, as an unalterable principle, the right of the people to support from their soil*. She brought Africans as slaves to the islands. In the ascendancy of the money power, even the subsistence of the slaves from the soil has been taken from them, and under the cover of apparent freedom, she has made their condition more subtly oppressive than it was in the past. The words of that great pope, Leo XIII: 'For every man has by nature the right to possess property as his own. Hence man should possess the fruits of the earth, but also the very soil', do not apply. They apply neither as to the soil nor as to the fruits of this very fertile island earth. The money power once again emerges as the enemy of the people's source of life.

We will continue with Mr. Stannard's words: 'Only by a reversal of the policy which prefers money crops to food crops can the native labourer be assured of the conditions which make a civilized life possible. Apparently the evil has increased in recent years. The Barbadian report is definite on this point. "In the old days plantation-proprietors planted a fairly large acreage in food crops, some of which were sold to labourers at preferential rates. But in recent years the cultivation of food crops has been so curtailed that the price of locally grown vegetables is so high as to be beyond the

modest means of the labourer ... The absence of fresh vegetables and proteins in the diet of the labourer is, we gather, having a deleterious effect on his health and physique. In short, the modern methods, which have tended to divorce the field from the sugar factory and make of them distinct and separate entities of plantation economy, have worked to the detriment of the field labourer".' The quoted Barbadian report, it will be noted, uses emollient phraseology, such as 'we gather', 'in short', 'have tended', 'the detriment', to blur the stark reality. Mr. Stannard, however, is in no doubt about the reversal of the policy, *re* money and food crops. 'In the Dutch East Indies', he writes, 'land sufficient to meet the needs of the whole population is earmarked for food crops before any money crops are allowed to be grown.' Therein is the difference between the British West Indies and the Dutch East Indies.

Our fertile islands now exhibit the stigmata, which, under urban conditions in Britain, have come to be known under the slogan of Scarcity amidst Plenty. Here are plentiful soils in a plenteous climate, and the stigmata which the British have incurred by their values are those of extreme poverty in the homes and malnutrition of the mass of the people. From cold, of course, the people cannot suffer and so their hovels have not to take upon themselves the protective character of northern homes. But, with this sole advantage over the northern island to which they belong, the people seem to be as far from plenty and as near destitution as a people can be. Mr. Macmillan, from his personal investigations, states that the spending power of the average citizen is so low that it is scarcely above that of the people of one of our more recent colonies, Nyasaland. But in many ways the islanders are what is considered advanced. The Barbadians, so many of whom cannot afford fresh vegetables, apparently take pride in calling their island 'Little England', since, though it is smaller than the Isle of Man, it supports, if not available vegetables, an Established Church, two Chambers, a Court of Grand Sessions, eleven Parish Vestries for local government, and probably the best educational system in the West Indies.

Agriculturally, the Barbadians are careful and skilled cultivators of cane. Their fields are clean and well tilled, and 'a respectable tradition demands a serious effort to find and make work for as many hands as possible ... for an abnormally dense population of more than 1,000 to the square mile by intensive island-wide cultivation of the sugar-cane'. Out of 176,000 inhabitants, some 18,000 are said to be small holders of a total of 14,000 acres, so 77 per cent of the small holders have less than an acre. Moreover, the land which the peasants do get for themselves is 'only the poorest soil. Quite often it is the land of some estate ruined by its European owner's bad and indifferent cultivation; but European critics are quick to point a finger and judge peasant possibilities by failure in such conditions ... Barbados, however, in face of a most serious population problem is in fact dead set against the peasant solution. Peasants, it is held, have failed to maintain the output, which has so far kept the island going, and so long as cane is the only industry nothing but the highest possible output will suffice. The peasants, however, have had their chance only on poorer soil, without organization or even sympathetic direction. The Barbadians, moreover, have no experience as peasants, little tradition but of supervised plantation labour. Though

intelligent workers under direction they would not be at their best as individual cultivators. In the long run the only alternatives for Barbados would seem to be great industries absorbing much labour and making the island more like one town -- or a steady flow of emigration' (Macmillan).

Barbados and Antigua lack the range of mountains of most other islands in the West Indies. They have, therefore, been given over to mono-culture, that of sugar and, as Macmillan states, have no experience as peasants and little tradition but of supervised plantation work. They are, therefore, the most widely separated of all agricultural labourers from the families of the East Indian island of Lombock.

The other islands, in this, have great advantages over them. Let us take Jamaica, the largest island of the British West Indies with its 4,550 square miles and nearly a million inhabitants, as the chief example of an island with a central range of mountains.

Mr. Macmillan writes: 'The Jamaica peasant tradition is due not to any special aptitude of the slaves imported, but rather to the fortunate juxtaposition of ample valleys and less accessible but still fertile and attractively habitable hill country; this accident gradually led the estate owners, as seldom elsewhere, to leave some of the slaves to grow their own food supplies. Thus a strong agricultural tradition was established and has persisted. After Emancipation many freedmen became independent cultivators and the Jamaicans, though they may be less disciplined, to some extent escaped the routine work characteristic of the sugar islands.'

It has been said that there are no less than 150,000 smallholders. Mr. Macmillan, however, doubts this and declares that 'peasant lots are now obviously too few and too small to provide an adequate living for any sufficient number of Jamaica's million inhabitants'.

Some few are successful and have saved money from their farming. But they do not use their money to improve their land, but to buy up more land. They buy up the land of their weaker brethren, who then become their tenants. They are no careful partners of the soil. The values under which they live are those of private property and individuals, the survival of the fittest, and not of the controlled, recurrent creation of the well-farmed soil. So the successful peasants imitate the white landowners. Frequently they overreach themselves by taking too much land, while the white landowners, on their part, continue to hold only partially used estates in the hope that fortune will change and bring a better market. The final human stigma of an ill-founded agriculture then appears: 'Control if not ownership passing into the hands of banks or business firms ... the almost unseen change of control from private landlords to outside mortgagors.'

So peasant ownership as a policy languishes in the mountainous islands of the West Indies, as it does in England. 'In enlightened circles of widely different views', writes Mr. Macmillan, 'the approved policy, so far as there is a policy, is to offer

opportunities of rising to peasant-status to as many as possible of this heterogeneous mass of small tenants -- a few of whom originally set the fashion without help. Official encouragement has been strongly pressed by individuals -- especially by Sir Henry Norman, ex-Governor, head of the West Indian Commission of 1897, and following him, by Sir Sydney (Lord) Olivier in his Governorship of Jamaica; but it is still only an aim, not an achievement. Even the aim has usually been hesitant. It is not quite clear whether peasants are to be relied on for the main agricultural production of the country, or whether peasant-ownership is only a means of relieving unemployment.'

The final terminus of ill-founded agriculture also now shows itself in these naturally luxuriant islands. Erosion of the soil is at work ... 'Different factors are concerned with the erosion which is occurring in many of the islands of the West Indies,' writes Mr. R. 0. Whyte. 'In Jamaica, small tenant farmers have practised shifting cultivation, paying rent for, say, one acre but burning and destroying forest over a very much larger area. In addition, accessible areas of forest have been heavily over-exploited, and there are insufficient Forest Reserves. In the plantation districts all land fit for this type of cropping has been cleared, but in addition, excessively steep slopes have been disposed of to petty settlers, for the production of foodstuffs ... Deforestation has also been excessive on some of the Windward and Leeward Islands. For example, a critical stage has been reached on the island of St. Vincent ... In Trinidad, felling of protection forests and shifting cultivation have caused serious denudation, erosion and severe flooding in the Maracas Valley and the Caroni plain.' Particularly valuable is the result of a reconnaissance survey of the United States island of Puerto Rico. It was found that 'there is slight erosion on 19 per cent of the island, mostly on cultivated parts of the coastal plains and alluvial valleys or on gently rolling pasture lands; moderate erosion was found on 29 per cent and severe erosion of about 39 per cent on the area. Most of the severe erosion occurs in the rough mountainous interior. Sheet erosion is the most common type, with gullies occurring on a little less than 22 per cent of the area.'

The same author elsewhere in his book writes of two British islands, scarcely less fertile than Puerto Rico and Jamaica, where a similar wanton disregard of the soil 'threatens to leave the country like an emaciated skeleton'. It seems that this haunting vision of the South Pacific now reaches the lovely-bodied islands of the Caribbean Sea.

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Chapter 18

German Colonies: The Mandates

The Germans were the last Europeans to colonize. They were also the people most imbued with the faith of modern science, and this taught them, with a clear conscience, to pursue the rights of the fittest to its extreme, logical conclusion. Armed with this faith, they conquered three areas in Africa: South-west Africa, the Cameroons, Tanganyika.

The Germans date their colonial empire from 1884, when Lüderitz hoisted the German flag at Angra Pequena, a port of South-west Africa, Nachtigal did the same at Duala, a port of the Cameroons, and Karl Peters and his companions landed at Zanzibar. So began their part in the exploitation of the Dark Continent.

Many countries had preceded them, Portugal, Britain, France and Belgium and, in their exploitation of their new territories, had not always refrained from cruelty. One of them, Belgium, under the influence of its king, was in the nineties to give an example of cruelty on such a large scale and so pitiless that, when knowledge of it became public, it projected a widening wave of horror through the United States, Britain, France, and Belgium itself. The period of harsh treatment of natives had come to an end as far as the great publics of Western Europe and America were concerned.

With this equal start in the three colonies in the year 1884, the German version of the policy of exploitation began.

As regards South-west Africa, a dry land and chiefly of agricultural value because of its pasture land, Paul von Rohrbach defined the policy in the *Deutsche Kolonialwirtschaft*, in these words, as quoted by Mr. G. L. Steer in his book of convincing thoroughness, *Judgment on German Africa*, 1939: 'The decision to colonize South-west Africa could after all mean nothing less than this: that the native tribes would have to give up their lands on which they had previously grazed their

stock in order that the white men should have the land for foraging their own.'

The Hereros and Hottentots were the chief peoples concerned in this appropriation. It was begun with a harsh oppression of both peoples, particularly of the prouder and more warlike of the two, the Hereros.

One of their chieftains described the German methods in words, again quoted from Mr. Steer's book, which is my guide in this chapter: 'Our people were being robbed and deceived right and left by German traders. Their cattle were taken by force. They were flogged and ill-treated and got no redress. In fact, the German police assisted the traders instead of protecting us. Very often one man's cattle were taken to pay other people's debts. If we objected and tried to resist, the police would be sent for and, what with floggings and threats of shooting, it was useless for our poor people to resist. If the traders had been fair and reasonable, like the old English traders, we would never have complained. But this was not trading at all. It was only theft and robbery.'

The Hereros rebelled in 1904, and fought according to their savage code, calculated to call for reprisals. They were defeated and, to finish the work, General von Trotha issued an order of total extermination, the Vernichtungs-Befehl. This is how it ran:

'I, the great general of the German soldiers, send this letter to the Herero nation. The Hereros are no longer German subjects. They have murdered and robbed, they have cut off the ears and noses and privy parts of wounded soldiers, and they are now too cowardly to fight ... The Herero nation must now leave the country. If they do it not I will compel them with the big tube. Within the German frontier every Herero, with or without a rifle, with or without cattle, will be shot. I will not take over any more women and children, but I will either drive them back to your people or have them fired on. These are my words to the nation of the Hereros. The great General of the Mighty Emperor, von Trotha.' By the end of 1905 official extermination had reduced the Herero people from 90,000 to 15,000.

In October 1904 the Hottentots also rebelled and were partly exterminated. As to the *human* result upon the Protectorate of the policy, Leutwein, the German historian of the south-west, declared: 'At the cost of several hundreds of millions of marks and several thousand German soldiers we have, of the three business assets of the Protectorate, mining, farming and native labour, destroyed the second entirely, and the last as to two-thirds.'

Before the Germans were themselves conquered in the Great War, the condition of the natives is thus summed up by Mr. Steer: 'Officially still, the native was a State serf, guilty of serf-like offences. Out of 4,356 convictions against natives, in the Protectorate between 1 January 1913 and 31 March 1914, 3,167 were for desertion, negligence, vagrancy, disobedience, insolence, laziness and contravention of the Pass laws; crimes not of man against man, but of the slave against his boss.' This did not

include the punishments of 'Väterliche Züchtigung', or paternal punishment, allowed to the German master over their serfs, which led Governor Seitz, in order to avoid a further native revolt, to threaten in 1912 'to withdraw labour supplies from those "who rage in mad brutality against the native, and consider their white skin a charter of indemnity from punishment for the most brutal crimes".'

After the Great War, South-west Africa was allotted as a Mandated Territory to the Union Government of South Africa.

In the Cameroons the Germans adopted the same policy, but it did not lead to any rebellion and annihilation such as that of the Hereros. The policy was to hand over the land and the natives, as and when required, to great German commercial companies. Governor Jasko von Puttkamer was the chief support of these companies and he carried out the government with German efficiency in their interests. 'Administrative recruitment' was the name under which the natives were used precisely and only as the planters and traders needed them. At first rubber was the chief source of wealth, but when the energetic Puttkamer in 1895 saw the coffee, cocoa and banana plantations on the neighbouring Spanish island of Fernando Po, he initiated estates for these products upon the lower lands of the lofty peak of Kamerun. Concessions were given by Puttkamer to German companies, and plantations were opened out on land taken from the Africans in possession, who were induced to work for the planters by being left sufficient plots on which to grow their own food.

The demand for porterage now increased to carry the products of the new plantations, as well as the rubber, to the coastal ports. Men were taken from their farms and families by 'administrative recruitment', to carry loads on ceaseless journeys, the police acting, as in South-west Africa, on behalf of the planters and in no way protecting the natives. For the sake of the planters, 10 per cent of the population were forced to be their serfs.

Puttkamer's exactions, financial machinations and private life were rooted out by the Social Democrats in Germany. He was disgraced and dismissed in 1907, but so wealthy and influential had the planters become that his policy continued to dominate in order to keep the labour market full, which the disease and hardship due to porterage in particular depleted. A better spirit prevailed or was enforced upon the German Colonial Ministry. A German medical service was organized to check the loss of labour due to diseases, the most feared of which was sleeping sickness. Some little official attention was also paid to education. One thousand children were to be found in government schools in 1914 and there were 40,000 in German and American missionary schools. There were reforms but minor reforms. As far as they went, they were for the good of the natives, but 'administrative recruitment' remained. The natives were still the serfs of their masters and discipline was enforced by severe paternal punishments. Planters were accused of the 'physical and moral annihilation' of the native, and it was not until the fatal year of 1914 that the Colonial Minister, Dr. Solf, was able to announce a doctrine new to the Germans: 'The colonies will prosper with the natives and for the natives, not in spite of them and against them.'

After the Great War the Mandate for the government of the German Cameroons was divided into two. The greater share was given to the French, the lesser to the British. The French now ruled a population of 2,400,000; the British one of 800,000.

The conquest of the third colony, Tanganyika, was due to Dr. Karl Peters. Of Dr. Peters, Mr. Steer writes: 'Of all the German pioneers Hangman Peters was the most unprincipled and bloody. I have not written of his cruelties, because I do not regard him as typical of the old German colonists; none but Trotha was as foul as the merciless doctor. But evidently the Nazis of 1934 held him to be typical; nay more, a prototype. Their propaganda has pursued him with praise in the five years since they gummed a memorial to him on their envelopes,' for his portrait figures on a stamp, which celebrated Germany's Colonial jubilee in 1934, and is placed as the frontispiece of Mr. Steer's book.

In 1888 Dr. Peters acquired Tanganyika by what Mr. Steer calls 'a novel piece of international theft, to which all civilized powers were parties'.

For ten years Peters conquered and enjoyed his power sadistically. Then his hangings and shootings of natives and the flogging of his concubines became known to the Social Democrats of the Reichstag. In 1897 he was brought to trial before the German Colonial Disciplinary Court. He was dismissed from the governorship and took refuge in England. Nevertheless, the hatred which he had aroused amongst the natives did not subside. Too many German bullies remained behind; too many native chiefs had been robbed. One called Mkwawa rebelled; and was defeated. His German conquerors cut off his head and actually sent it as a trophy to Berlin. A special clause was inserted in the Treaty of Versailles which ordered its return to his tribe.

A more serious rebellion, that of the Maji-Maji, of the combined tribes of the south, raged for two years. The Germans, failing to overcome the Africans in the field, destroyed their villages and crops by fire. Thousands of Africans died of starvation and the entire south of Tanganyika was devastated. Money became frightened and so, in 1907, Dr. Dernburg, an able business man and banker, who had been given the new appointment of first Secretary of the Colonies, left for East Africa to institute reforms and to endeavour to turn the hatred of the Africans into their natural tolerance, if not affection. Very shortly after his arrival, he announced publicly: 'I saw too many whips in the hands and on the tables of the planters and colonizers.' He attempted to permit the natives to be free producers, as well as to free those who were in German employment, limiting forced labour to public works and paying it for its work. The planters were rendered bitterly hostile by these humanities, and succeeded in enforcing Dernburg's resignation. In practice, therefore, the seizure of land, forced labour, floggings and imprisonment continued until the Great War.

After the Great War, the Mandate for Tanganyika was allotted to Britain.

The Permanent Mandates Commission of the League of Nations brought a redemptive

spirit into governance. Under the first clause of their charter, they were to be *the trustees of the material and moral well-being of the natives*. Each Mandatory Power had to present an annual report for acceptance and suggestions by the Commission. Reports and comments were made public. The old-time secrecy which was able to screen offences was made impossible. Mr. Steer, in his chapter on 'Mandates' Work', gives a most moving account of the improvement of the lot of the sons of the soil, which had once formed the territories of the German northerners.

Of South-west Africa, he states: 'It has multiplied by ten, the amount of land in the hands of the native in German days, and it has enabled him to keep herds of cattle and sheep again, a tribal necessity of which Germany cruelly deprived him.' The mandated natives are even better off in the south-west than are the natives in the Union; the former, for example, have to pay no poll-tax which often forces the Africans into industry where their wages never rise; their tribal institutions have been restored and the chiefs in the far north actually share in the responsibility of government. The white men, who now direct the country, are men of the Union and, therefore, versed by experience in the type of land of the south-west as also in the native character. No gross cruelties now occur, and, did they do so, they would be reported in the annual reports to the Permanent Mandates Commission. The general result has been a notable increase in prosperity.

In the Cameroons under the French Mandate there has been a similar new spirit of humanity, carried out in the way that is especial to the French. Everything local, social services, State services, the construction of the wonderful French roads, education, public health, co-operative agriculture, emanate from the top. The French have no faith in ancient systems and traditions; that they have destroyed in their great French Revolution of 1789. They have not therefore set about strengthening the tribal chiefs and restoring tribal institutions. 'Governors sack chiefs on any pretext,' says Mr. Steer. 'Tradition to them is a thing that clogs.' With the network of roads which the French build, they introduce speed of communication, enabling them to establish centralization in place of the old local administration. Within these limits, they give the Africans freedom, public service, instruction and medical aid.

Under the Mandate, French authorities have to publish, for all who wish to read, their annual report to the Mandate Commission, and it is due to this, says Mr. Steer, that the French Cameroons have the advantage of their neighbour, the non-Mandated French Equatorial Africa, whose reports are seldom read outside the Colonial Ministry. The officials of the former are spurred by the knowledge of the coming publicity. The consequence is that, whereas the Cameroons grow in strength and population, Equatorial Africa wanes in both. Under eager but careful officials, the freed natives are themselves infused with energy and zeal, and take a growing part in production. 'Production', writes Mr. Steer, 'is balanced nicely between white and black ... Some crops, such as cocoa, which were exclusively European, are now exclusively African ... Production has become so popular a pastime that the sources of white labour have dried up.' This energetic spirit has advanced hand in hand with prosperity,

with the result that 'the French Cameroons balance their own budget; they have only in the 'thirties borrowed money from France, and their total debt is infinitesimal. Neighbour Equatorial is one of the territories which promotes most gloom in the French Colonial Ministry. There is always a colossal deficit. Sometimes it amounts to 30 per cent of the total receipts. There is always a crushing debt.'

The British in Tanganyika have worked in the opposite way to the French. Sir Donald Cameron, who knew, as no one else, where, how and to what degree self-government could be developed, gave this succinct account of his British methods: 'We built from the bottom, from the common people upwards on a purely democratic basis, in distinction from other countries, where the tendency has been to invert the pyramid and build from the top.' The spirit of the Mandates was most acceptable to his humane and understanding heart. Mr. Steer's words on this are so nobly eloquent that they will be quoted in full: 'The Mandate for Tanganyika, as for the Cameroons, destroyed the system of forced labour set up by Germany; it has assured the native primary rights in the land of his fathers, and a paramountcy of his interests where they conflict with those of European settlers -- where the German policy was diametrically opposite; it has constructed a peaceful native peasantry where none existed before; it has given peace for armed repression; impartial for rough justice.

'Above all it has established the natural foundations of native society where these had been hammered out of sight by the German machine. It found an oppressive and foreign rule in Tanganyika twenty years ago; in that brief time-period it has not only restored the native system, but given it responsibilities of which it never dreamed before. The native authorities, suitably democratized, spend their own money, hold their own courts, carry out their own measures of education, hygiene, and all other forms of local government.

'There is no need to compare Tanganyika with Kenya or Nyasaland on her northern and south-western frontiers. Through the breadth of Africa south of the Sahara you will not find a territory where the native African has such freedom of self-expression as in Tanganyika; or such grand responsibility; or responsibility so faithfully borne. When one lifts the veil of wishful thinking and asks, in a clearer atmosphere, what is the purpose of colonial government, clarity demands no stupid answer such as raw materials for the mother country (seeing that all the colonies of the world produce only 3 per cent of the world's raw materials), or pockets for European investment (seeing that the beneficiaries can only be the few), or strategic power (seeing that if war is permanent life is not worth living). No; the light shines too hard to-day to admit evasion. If we are to remain in tropical Africa we are there for the benefit of the people whom we rule; and their benefit is not only to learn and be healthy, have peace and produce; the greatest gift we can offer them is the opportunity to manage their affairs. That is why Cameron justly said, "We have given back their soul to the people".'

The Mandates in the three countries have been carried out in three varying ways by the Union of South Africa, the French and the British, but each method has been

inspired by the new spirit. It is this that has led to their success and prosperity, for Tanganyika too is prosperous, 'the richest of the former German Colonies'. The, Mandates, indeed, have worked like a *miracle of social benefit* and civilization in these three countries, especially in Tanganyika. It is very impressive and will become yet more so to the reader of Chapters 21 and 22 in which similar miracles on a grander scale of civilization will be described.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 19

Russia, South Africa, Australia

Russia

The land of European Russia is not complicated. It is the direct extension of Belt No. 1 of Asia, described in Chapter 6. Its sea-coasts are too limited and removed from the open ocean to alter its essential character, which, with its situation between Asia and Europe, directed the history of the Russians.

Its physical map is, therefore, mostly tinted green, indicating an elevation up to five hundred feet. It has two irregular areas of yellow, of elevation up to two thousand feet running north and south; one to the west, the second to the east. The eastern is intersected by a thin strip of light brown, of elevation up to five thousand feet, the Ural Mountains. These west and east areas are in latitude 60 degrees joined by a transverse yellow band. The three areas form the watersheds of Russia's rivers. Two considerable rivers, the Dwina and the Petchora, open into the Arctic Ocean, but the largest Russian rivers, unlike those of Siberia, run south. The Volga rises from all three watersheds, west, east and transverse, and runs into the Caspian, its last section in the Caspian Tract being actually below sea level. The Don rises from the eastern side of the west yellow area, and the Dnieper from its western side, and also by its big tributary, the Pripet, from the northern Carpathian Mountains outside Russia. Both flow into the Black Sea. The Dniester, also entering the Black Sea, forms the south-western boundary of Russia.

Russia is thus an extension of the Siberian Plain, made European by the Ural Mountains. South-east Russia, with the Caspian Tract, is the European extension of the Asiatic Kirghiz Steppes. Through the Steppe country many Nomads of Asia passed into Europe and, at a later time, Russians passed into Asia.

At the time of the last Glacial Age, nearly all European Russia was covered with ice.

As the ice receded, Russia emerged in a sodden condition of boggy lands and lakes, the abundant waters of which were drained away by the great rivers.

In the drying up of the Post-Glacial epoch, Russia slowly attained to the condition of being habitable to men. European Russia is now divided into three belts.

Firstly there is the northern belt, with its Arctic tundra cap, with a long winter, a brief summer and a saturated, boggy soil. It offers only the most limited opportunities for farming.

The central belt has a more equable climate than the other two. Its soil is capable of receiving and storing water to a considerable depth, and it gets an abundance of water in the spring from the melting of the snows. Its surface then becomes a sea of mud, but five or six months of open season follows; the surface dries, and so becomes cultivable by men. This central belt, which contains the capital and other manufacturing towns, constitutes the farmed, but food-deficient area of Russia.

For these two deficient belts, Russia is compensated by the third or southern belt, the food-surplus area. Here the season of freedom from snow lasts up to nine months. Here also the extremes of heat and cold are greater than are those of the central belt. So dry is it at times, from the heat and the hot winds which sweep into it from Central Asia, that it is subject to drought. But its soil is rich, and that of the Black Earth Zone, immediately south of the middle belt, is the granary of Russia.

Russian agriculture began in the middle belt, the belt of forests. It was not until the reign of Ivan IV (A.D. 1533-84) that the grain land was reached. Sir Bernard Pares in his most instructive *A History of Russia*, 1944, states that the Russian peasants were peaceful men, seeking to cultivate land without interference. They would clean a piece of land along the bank of a river, burning down the trees and digging out the stumps. They would erect a colony of a few houses, keeping close to the river for fishing and transport. In the north they met the Finns, then entirely unorganized, and they established friendly relations, with them. 'The Russian peasant', says Pares, 'was a man of peace and he did not come to start new conflicts, but to avoid them.'

But they were not left at peace by their rulers at Kiev and Moscow for the reason that they were the source of the greater part of the wealth of a poor country and, secondly, because the army was recruited from them.

The chief enemies of the Russian people from about A.D. 1130 to the reign of Ivan IV were the Nomadic Mongols from Asia, who passed into Russia through the Caspian Tract. To preserve themselves and their peoples from the Mongols, the Russian rulers relied on the strength of the land and its peasants. When Kiev was the capital, the near land was in the hands of a landed aristocracy, the far in the hands of pioneer peasants themselves. When Moscow became the centre of the eventual Emperor, land was given to a second class of superior landowners, who were allotted it for their lifetime

on condition of rendering military and other service to the State. 'The conditions of tenure', writes Pares, 'stated precisely the number of recruits who had to be placed in line. The allotment of land corresponded to this number and was graded carefully according to class, which was practically synonymous with military rank'; and he adds that military service was also demanded from the hereditary landowners: 'the patrimonies themselves were put under the same obligation of military service, and, in fact, all land in Russia came to be held only by the title of service to the Tsar'.

'As a system of agriculture', continues Pares, 'nothing could be more unsound. The squire was firstly a fighter, only secondly a squire. His absences were frequent. His efficiency was rated only by his military service;' and, as regards the landowners of the second class, they could be moved at will, which prevented them from acquiring any permanent interest in their peasants.

The peasants were bound to the soil, for the aggression of the Mongols was 'such as to convince the dullest of peasants of the necessity of national defence and of national sacrifices'. Nevertheless, some peasants were bold enough to seek freedom from the oppression of their rulers and moved eastwards and to the south and south-east. 'Flitters', Sir John Maynard calls them in his fascinating *The Russian Peasant*, 1943, and it was the flitters who came to constitute the Cossacks, or border peasantry, who were so powerful a factor in the eventual repulsion and conquest of the Mongols. The Cossacks came to possess, writes Pares, 'wonderful military resource and were masters at taking cover. They practically never parted with their horses and were trained riders from childhood. Their scouting tactics were those of the Russian army of to-day. Tall lonely trees were used as observation posts; different points at some distance from each other were garrisoned, and between them relays of individual Cossacks patrolled, never dismounting'. Such men, therefore, enjoyed a freedom not given to the more central peasants.

Even when the Mongols were subdued by Ivan IV, the heavy burdens of the Russian peasants were not lifted. The danger to the Russian kingdom then shifted from the south and east to the west, as Europe advanced in civilization and military strength. The virtual serfdom of the peasants, severe according to their relative proximity to Moscow, was continued, and, in 1649, a code of laws was issued which 'finally confirms the establishment of serfdom, which henceforth becomes a state institution'.

Not even Peter the Great (A.D. 1682-1721), who in physical strength, will, genius and energy was perhaps the greatest of all European rulers, could relax the oppression of the peasants. It was he, above all, who realized that Russia was lost in the struggle against European aggression, unless her backward people were Europeanized. So, though 'Peter was far closer to the Russian peasant than any Tsar before him or since', his vast expenses forced him to increase the weight of the peasants' chains. Flitters to the freer south and south-east increased greatly in numbers, and some passed over the Urals into the land, familiar in character, of the Siberian Plain. As time passed, the freeing of the peasants from serfdom in order to promote the advancement of by far

the largest number of the Russians became more and more urgent, and eventually an Act of Emancipation was passed in 1861. It was in many ways ineffective, and the final stage of release came with the Soviet Revolution and the Collective Farms of Lenin and Stalin. Under the Collective Farms the medieval tempo of farming was transformed into modern farming of an advanced kind. Sir John Maynard, in his sixteenth chapter, gives a full account of these collective farms, with their advantages and difficulties, their tractor machines, their economics, their lack of sufficient manure, their associated work on the large farms, their personal work on their private farms.

From this account of the soils and their ownership it will be seen that two forms of erosion could have been witnessed in European Russia. The first would occur from the destruction, without afforestation, of the forests upon the slopes and watersheds of the higher land, if the land itself was owned by men who were anxious to get the most wealth from the soil without adequate return. When the forest had been destroyed on the slopes and watersheds, sheet and gully erosion would occur owing to heavy rain or melting snow. The rivers would, in the wet periods, then be in flood and bear top-soil to the sea; later on, in the summer season, their profitable streams would dwindle.

Such a dominance of money did, indeed, occur in historical Russia, particularly in the seventeenth, eighteenth and nineteenth centuries. Mr. Jacks' pronouncement, in *The Rape of the Earth*, on this cause of erosion is one with which we are already familiar. The peasants of Russia were serfs; all the profits of farming went to enrich a landed aristocracy. We are told: 'The landowners' aim was to get the maximum out of the soil in the shortest time with the least expenditure of labour and improvements. Sheet erosion was extreme, though generally unnoticed and not associated with the new gullies that continued to break up the land.'

Fortunately for Russia, the primitive farming of the serfs was very slow in extension. Though marshes and lakes dried up and the streams of great rivers flooded and dwindled, there was a tempo very much less than that of the United States under the era of the machine. Consequently, loss of the Russian soil was far from reaching the disastrous magnitude of that of the American soil.

When the serfs of Russia were emancipated in 1861 and became possessors of much of its soil, there was no halt in this form of erosion. The peasants were given the poorest eroded land and they, therefore, set to work to extend the cultivation of the slopes. Their method of ploughing was in long strips up and down the slopes to the tops of the watersheds; the hollows between the ridges became first water courses and then gullies and so erosion was increased. Even under the Soviets, no halt was called to the destruction of forests owing to the need of timber in exchange for the machines from foreign countries which the new manufacturing towns of the U.S.S.R. required.

So much for the first form of erosion, namely, sheet and gully erosion. The second

form of erosion is wind erosion. This would affect the third or southern belt of Russia, both the rich Black Soil Zone and the land of the Steppes. Here is what Major Law, Commercial Attache in St. Petersburg in 1892, reported upon this belt, once protected by belts of forests: 'It is certain that those forests do not now exist , and that the black soil country is often scourged by devastating blasts from the Steppes, and not infrequently baked by prolonged droughts.' Wind erosion and floods work their havoc and 'smite the soil with perpetual barrenness'.

This erosion at length aroused alarm in the Russian aristocracy and, in the eighteen-nineties, many shelter belts of trees were planted to break the force of the hot winds upon the top-soil 'on such a spectacular scale and with such excellent results that a special government commission was appointed to study afforestation' (Whyte, in *The Rape of the Earth*).

The sudden stride of the U.S.S.R. into the modern era, with its reliance upon machines, made the tractor-plough in particular a symbol of modernization. It became the visible image of the inner belief in the machine as a saviour, and wherever the tractor went it was heralded as a propagandist. Nevertheless, it had its intrinsic dangers. Messrs Jacks and Whyte, in the *Technical Communication No. 36 of the Imperial Bureau of Soil Science*, 1938, discussed this danger and quoted the Russian Professor Kornev as saying, with regard to both forms of erosion: 'At the present day there are huge areas in the U.S.S.R. where, owing to the excessive breaking up of the topography, whole territories, formerly under profitable agriculture, are now occupied by immense ravines and infertile wastes.' To this the two authors added: 'The tractor-plough is the enemy of the grass land in dry areas, but is indispensable to the propagandist of Russian agriculture. Though forewarned by the experience of other countries, it is difficult to ascertain if the authorities are aware of the danger of mechanization.'

Certainly, by the year 1938, the Soviet authorities had put tractors upon the land on a very vast scale. Whereas, according to Appendix III of the Trade Unions of the U.S.S.R. (quoted in the Fabian Essay on *Our Soviet Ally*, 1943), in 1913 no tractors were in use in the Russias; in 1938 there were used, upon the scientific, mechanized, collective farms, no less than four hundred and eighty-three thousand tractors. The potential threat of erosion in such numbers is enormous, as the consideration of the other three of the four great examples of modern erosion, South Africa, Australia and the United States, will show. The war and its demands have concealed the threat and even made it one that had to be concealed. No account of the degree of new erosion can, therefore, be given.

South Africa

South Africa is described by Mr. Whyte, in *The Rape of the Earth*, under the italicized sub-heading of *The Transformation of South Africa into Semi-desert in the Twentieth Century*. The agricultural wealth of South Africa is chiefly pastoral. The natural veld

and the Karroo provide animal fodder, though in favoured localities special grasses and foreign crops are grown. But this natural vegetative cover has deteriorated and 'erosion has already transformed parts of the richest pastoral areas in the country into semi-desert. Considering that the luxuriance and excessive wetness of the veld in the Orange Free State were previously an obstacle to pastoral farming, the rapid appearance of the disastrous consequences of erosion is very remarkable. It occurs in all parts of the Union, either as an actual or probable menace, and is predominantly a pastoral problem.'

He then continued with this important paragraph: 'The great uncertainties of the South African climate, and the suddenness with which the country was opened up after the discovery of gold, have contributed largely to the rapid acceleration of erosion. Towards the end of the nineteenth century it was realized that serious overstocking was taking place, but public attention was not focused on the danger until the Drought Investigation Committee issued its final report in 1923. Until then the opinion had been gaining ground that the climate was becoming drier and the rains more torrential. The report pointed out that there was no proof of a definite and recent climatic change, but that erosion would account for the drying up of rivers and waterholes, the falling watertable and the increasingly disastrous effects of droughts and heavy rains. The Commission concluded that the erosion was caused chiefly by deterioration of the vegetative cover brought about by incorrect veld management, and that all efforts to improve the latter would have a beneficial effect on the former.'

South Africa was taken from the Dutch by the British in 1812.

Australia

In the speed with which fertility of the soil is being lost, Australia is believed to surpass even the United States. This is the opinion of Mr. E. S. Clayton of the Department of Agriculture, New South Wales, who was sent to study erosion and anti-erosion measures in the United States for the better defence of his own country. In *Investigations Overseas*, 1937, he writes: 'There is no doubt that we Australians are in a process of transforming the semi-arid areas into desert at a more rapid rate than in the U.S.A.'

Australia is, in short, being threatened with becoming to the British Empire what Libya became to the Romans. The loss of soil from rapid deforestation and burning of vegetative cover and from overgrazing is severe. 'Approximately two-thirds of the area covered by the Alpine woody shrub type has been completely cleared by the action of fire,' writes Mr. R. V. Byles of the catchment area of Australia's greatest river, the Murray, in *Bulletin 13 of the Commonwealth Bureau of Forestry*. He continues: 'The organic layer, with no cover to protect it and no live roots to hold it, dries up and is blown away; the loose sandy soil is in its turn blown away, leaving the final product, bare granite rocks and stones with no vegetative cover.' The once constant river has become inconstant and its water is intermittently turbid in place of

the original constant clarity. 'In thirty years the land about it has become desert, according to the testimony of men who have nurtured cattle there all their lives.'

The eagerness for wealth in a country that does not nestle to the heart as does the homeland destroys the permanence of its gifts to men. There is no real ecological link between the white man and its nature, nor habit and tradition which expresses it. They do not feel that when they burn or tear its verdure they are tearing at their own home fields, at something which is an eternal associate of their own, and their ancestors' and their descendants' lives. It is land and land can give wealth, but it is not *motherland*, and, until that human term and what it implies in the fullest sense becomes bred in the bone, it will not be real, and *the land will not be properly treated*. It is the heart, faith, sentiment that ultimately prompt action.

So in the drier parts of Australia there are thousands of acres of lightly stocked pastoral country, which are suffering from erosion and where men, like fifth columnists, have helped the central desert to advance. Not only is the fertility of these undulating lands being depleted at an alarming rate, but the wetter, riverine districts near the sea are also in many parts gravely affected by erosion, due to the same eager speed to clear the land, as has already done so much harm to the riverine area of the great Murray River.

Finally, there are the rabbits, introduced from Britain to this, to the white man and rabbits, new world. In *Pamphlet No. 64 of the Commonwealth of Australia* there is an incomparably vivid picture of these pests given by Mr. F. N. Ratcliffe. In a way, the four-legged immigrants from Britain behave like the two-legged from the same country. When the going is good and there is abundant pasture, the rabbits do not act as if they were part of a country in balanced equilibrium, but as pitiless ravagers of its soil fertility. They revel in the rich harvest and they multiply out of all counting, as if the future must be a repetition of the past. In numbers they eat up the pasture and drive the hungry sheep to devour saltbush. They overreach their good fortune. Then come the hard times of a drier season. They are hungry, so hungry that they eventually eat all and any food within reach and even beyond the ordinary reach of their kind. They eat the surface plants. They climb. They burrow into the earth and get at the roots of the hardy acacia scrub. They take all that is above and below the soil and give it no chance of regeneration. Then comes a drought, and the rabbits die in heaps under the very eaves of the settlers' houses or wherever man-made shade can shelter them from the pitiless sun. So the rabbits, too, fail to fit into the balanced life which nature had long established in Australia, before they were brought out with the intention of providing food, not destroying it, for the white settlers.

The British first settled in Australia a century and a half ago.

The British annexed New Zealand, the islands of the 'emaciated skeleton' threat mentioned at the end of Chapter 17, in 1840, just over a century ago.

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by G.T. Wrench

Chapter 20

The United States of America

0f all countries in the world, that which is most typical of modern progress; that which, at its initiation, announced the gift of liberty to every man to pursue wealth within the limit of the law and has permitted the greatest liberty of thought and action on the part of its inhabitants of all ranks; that which has encouraged genius or avidity to develop themselves most freely in the belief that the accretions of knowledge and wealth, which would accrue, would be of ultimate benefit to the community and to humanity as a whole; that which has produced the greatest business achievements and made itself the nation with the widest scientific equipment and the most skilful practical technique; that which rushed forward into the new with such speed and eagerness that the old has been forgotten; that upon which nature has now written most broadly and definitely her grim judgment in terms of erosion of the soil; that which, with its accustomed, heroic practicality, is now surpassing all nations similarly stricken in the vigour and thoroughness of its measures to oppose this life-destroying menace; is the United States of America.

In April 1928, the Agricultural Department of the U.S.A. published Circular No. 33, by Messrs. H. H. Bennett and W. R. Chapline. The circular bore the title of *Soil Erosion: A National Menace*. It is divided into two parts, a general consideration of the loss of soil due to erosion by the first author, and of the erosion of grazing lands by the second. It consists of thirty-five pages and contains thirty-five photographs, and he who looks and reads, especially if it is his first intimate meeting with the question, finds a graphic revelation of the greatest rebellion of our time, the rebellion of the earth itself. The figures of destruction given are colossal, and when one looks at the photographs and sees these figures embodied in visual reality, the effect is so impressive that one understands how it is that this short pamphlet in particular assembled the voices crying in the wilderness and made them startle into attention the governments of the world.

Mr. Bennett, after a few preliminary remarks, gives an exposition of the *Figures on Soil Wastage*: 'The amount of plant food in this minimum estimate of soil wastage by erosion (1,500,000,000 tons of solid matter annually) amounts to 126,000,000,000 pounds, on the basis of the average compositions of the soils of the country as computed from chemical analyses of 389 samples of surface soil collected by the Bureau of Soils. This is more than twenty-one times the annual net loss due to crops removed. The amount of phosphoric acid, nitrogen and potash alone in this annually removed soil material equals 54,000,000,000 pounds. Not all of this wasted plant food is immediately available, of course; but it comes principally from the soil layer, the main feeding reservoir of plants, and for this and for other reasons it is justifiable, doubtless, to consider the bulk of it as essentially representing lost plant food, without any quibbling about part of it having potential value only.'

It is impossible to get a succinct method of thinking out the meaning of figures so colossal. One can put them before oneself in some such way as this: There are 120,000,000,000 pounds of plant food lost by 120,000,000 people. The permanent loss of plant food, therefore, is at the rate of 1,000 pounds per person in the U.S.A. As each person eats about 1,000 pounds of food a year as plant substance or as animal substance derived from plant substances, one can get some sort of equivalent conception as to what this means. Nor is this all. The destruction is proceeding at an 'ever-increasing rate' as we shall see in the next quotation from Mr. Bennett. Clearly such a system of treatment of land cannot indefinitely continue. One recalls again here the prophetic words of Professor Shaler of Harvard uttered thirty years before the publication of this pamphlet: 'If mankind cannot design and enforce ways of dealing with the earth which will preserve the sources of life, we must look forward to a time -- remote it may be, but clearly discernible -- when our kind, having wasted its great inheritance, will fade from the earth because of the ruin it has accomplished.'

There is something, too, paradoxical about these millions and thousands of millions of figures, attached to something so general to man as the soil, that allies them to those of the money system of the same period. Farmers create what men eat, but in doing so create life-strangling erosion and deserts. In the money system, financiers create money for men's livelihoods, but in doing so they also create life-strangling debts and financial deserts. The vast accumulation of negative money, as national and municipal debts, runs into figures comparable to those concerned with negative soil. The two seem to have a definite kinship. Yet urban peoples still view both their food methods and their money methods with a scarcely shaken trust. Again the split mind gives evidence of itself.

There are further figures. The loss of phosphorus, potash and nitrogen alone, without reckoning other soil foods, is estimated at 2,000,000,000 dollars a year, which is the better portion of the British national revenue before the war of 1914-18. Mr. Bennett, writing in 1928, which he denotes as a time of meagreness of fundamental data of 'what is going on at an ever-increasing rate', states: 'That some 15,000,000 acres or more of formerly tilled land has been utterly destroyed by erosion in this country is

but an insignificant part of the story, for it is the less violent form of erosional wastage, sheet erosion, that is doing the bulk of the damage to the land. Land depreciation by this slow process of planing off the surface is of almost incalculable extent and seriousness, and since the denudation does not cease when the subsoil is reached, there must be in the near future, unless methods of land usage are very radically changed, an enormous increase in the abandonment of farm lands.' Nine years later Mr. E. S. Clayton of the Agricultural Department of New South Wales, after his study of erosion in the U.S.A., came back with the momentous figures: 50,000,000 acres of cultivated land destroyed, 50,000,000 acres seriously eroded and about to be abandoned, 100,000,000 acres with loss of much of the topsoil, out of 987,000,000 acres, the total of agricultural land in the States. Finally the United States Department of Soil Conservation Service published a map with various shading to show the areas of slight and severe wind erosion, and slight and severe sheet erosion due to widespread movement of thin sheets of water. The unshaded non-eroded areas contrast with a widespread prevalence of shade. The above figures of Mr. Clayton are certainly not belied by the map.

The figures of loss in the U.S.A. are, indeed, incredible, in that the mind cannot grasp that a country of incalculable national wealth and fertility, almost within a century can be thrust into such danger. This is but a paraphrase of Mr. Bennett's own summary: 'To visualize the full enormity of land impairment and devastation brought about by this ruthless agent is beyond the possibility of the mind ... Any American of live imagination knows that the people of the United States would willingly spend 20,000,000,000 dollars to redress the wrong', had it been due to a foreign foe. But because it is an inner fault of American thought, because the sun, the wind and the rain, the natural conditions of earthly life, are concerned, the people scarcely heed it. So Mr. Bennett ends his part of Circular 33 with the words: 'A little is being done here and there to check the loss -- an infinitesimal part of what should be done.'

Then comes the visual evidence, the photographs from many of the States. In the first photograph one sees a sloping cotton field showing shallow channels caused by rain between the rows of plants. When heavy rains came and the extensive field had only a light cover of young plants, then more water ran along these channels between the plants than where the soil was held by the roots of the plants. This is sheet erosion; some water sinks into the soil, but some runs away without sinking in. The runnels collect together and form a gully. The next photograph shows the result of gullies, which have collected together to one channel in the Greenville fine sandy loam. The channel is a chasm 100 feet deep, with precipitous sides, fringed by forest trees. Where it now is, there stood a school-house forty years ago.

There follow further pictures of erosion due to rain and melting snow. There is one of a wide, laterally extending gorge in the Mississippi Valley; one of cornfields covered with a blanket of coarse sand deposited on it by the erosional waters of heavy rain; arable land in Kansas so cut up by gullies that it could no longer be ploughed and was given over to pasture; bald patches on the rich, black soil of Iowa, washed away by sheet erosion and showing the clay beneath; smooth fields in Texas split by gullies as

a flat glacier is split by crevasses; rolling, hilly country of Northern California, once forested but now complete desert, with no topsoil and what is left of subsoil slashed by gullies; a spacious hilly area in California left desolate of growth by fire and water; in Virginia erosion following a few drops on slopes which should never have been cleared; in Colorado, farm buildings caught and undermined by a wide stream, the natural obstructions to the free flow of which the owners of the buildings had themselves removed; wagon tracks starting eroding streams, which will eventually lead to the loss of a valley full of rich soil; driftwood and other debris from hills made barren by fire and deposited by flood upon a young orchard; wind erosion due to trampling of an excess of cattle in dry New Mexico; vegetation destroyed by smelter fumes over thousands of acres in Arizona. The last picture of all is one that cheers the heart after so much witness of destruction. It is one of 'abundant and excellent feed and a maximum of watershed protection', in Montana. It shows a well-watered, hilly country bearing tall fir trees, bordering upon spaces of rich grass, and in the foreground, a flock of feeding sheep. The land and its cover are good and man himself joins in its life-cycle with his good flock.

Nevertheless, Montana takes its share of the famous grazing grounds of the North-West, where it is said that 58,000,000 acres are now only able to feed one-fifth of the number of animals they were once able to support. But it is in Montana's neighbour, the Pacific North-West, that something very positive has arisen, an action of new values in keeping with the awakening of Americans to the primal value of a sheltered soil, protected by a continuous ownership of those who will care for it on small-sized farms. Once again the land is to be the centre of homes, a homeland.

In the Pacific North-West flows the great Columbia River, across which have been placed two dams, the Bonneville and the Grand Coulee. These two huge dams will produce more electric power than the 14,082,282,000 kilowatt-hours turned out by the two hundred and sixty electric plants in the State of New York.

What to do with this enormous amount of energy? There enters into this question something strange and new to accustomed industrialists. They wanted a vast factory community near the Bonneville Dam itself. But there were eyes of a great leader looking upon this mighty dam before him and looking also beyond it with the vision that extends what is seen into the realms of the future. In September 1937, it was this leader, President Roosevelt, who delivered a speech of dedication beneath the dark crags of the Columbia Gorge, the river of which in its change now foretold a change for the mighty stream of the American people.

The North-West, consisting of the States of Washington, Oregon, Idaho and the section of Montana west of the crest of the Rockies, offers an opportunity, said the President, 'to avoid some of the mistakes and wasteful exploitation of resources that have caused such serious problems in other parts of the country'. The North-West should not be a land of new 'Pittsburgs'. The President continued: 'It is because I am thinking of the nation and the region fifty years from now that I venture the further prophecy that as the time passes we will do everything to encourage the building up

of smaller communities of the United States. To-day many people are beginning to realize that there is an inherent weakness in cities which become too large, and inherent strength in a wider geographical distribution of the population.'

The Grand Coulee, now nearing completion, in addition to providing power, will irrigate 1,200,000 acres. These acres are to be given to families and small cultivators. They are being protected against combines and other large-scale operations. These types of land-ownership are forbidden. Land, held in defiance of this limitation, will get no water from government canals. Families, who have been driven by erosion from the western grazing lands and migrated from the now famous Desert Bowl, will here find land. Some are doing so now. The amount of land allowed to be held is limited to eighty acres for a family and forty acres for a single man. The purpose of the Grand Coulee is to take care of as many families as possible. The partnership of family and soil is to be revived. But there is to be something more on this irrigated land. There are to be small industries served by electric power. Men and women, who work at these industries, will also be able to have kitchen gardens, and thereby will carry out what Mr. Stuart Chase proposed several years ago for the North-West, small farms which will act as 'anchors to windward', if at any time industry fails.

Everyone in this area will have the opportunity to gain soil-sense. The land as food producer will be the basis of society and will be its associate. Many small industries dotted about the North-West will serve the countryside as once did village crafts. Other industries will develop for industrial purposes the raw materials of the local farms. Industry will be truly distributed; it will administer to the comfort and happiness of the people on the land as its primary object, and act as the means of external trade as its secondary object. The dicta, indeed, of the North-West, will be those so concisely expressed by Napoleon at St. Helena: 'Agriculture is the soul, the foundation of the Kingdom; industry ministers to the comfort and happiness of the population; foreign trade is the superabundance; it allows the due exchange of the surplus of agriculture and industry ... Foreign trade, which in its results is infinitely inferior to agriculture, was an object of secondary importance to my mind. Foreign trade ought to be the servant of agriculture and home industry; these last ought never to be subordinated to foreign trade.'

The cost of the electric power of the Bonneville Dam is governed by 'postage-stamp rates' all along its transmission line of 275 miles; the industry farthest from the dam pays for its power at the same rate as the industry that is nearest. This mandate was not directed against industries and factories as such, but against industries and factories compounded into places like Pittsburg, Chicago and Detroit. The fear of the great metropolitan city is so ingrained in the thought of the people, writes Mr. Richard Neuberger in *Free America*, August 1940, in a quite triumphant article from which I have taken my information, that during the struggle over the Bonneville power rates, the words of President Jefferson (1743-1820) appeared in many local papers: 'I view great cities as pestilential to the health, the morals and the liberty of mankind.' That saying was directed against financial and industrial magnates, ambitious politicians

and demagogues, who arise in cities and only by cities are made possible. The logical end of metropolitan civilization,and its most complete, one-piece form, is totalitarianism which is confessedly and in action 'pestilential to the liberties of mankind'. In this scheme in the Pacific North-West, men and women have now the opportunity to combine manufacture with a home partnership with the soil. The soil, once again now, and yet more in the future, will be their associate and instructor. There is a grandeur about the scheme, which belongs to a great country that can still revive its epic character.

There is another illustration of the redemptive spirit in the U.S.A. which stirs hope and admiration no less than the story of the Grand Coulee. It is the story of a complete education of the children and people in the local soil.

It was called forth in an area of the United States by the great catastrophes of the Dust Bowl and the floods in the basin of the Mississippi River and eventually united all classes of the inhabitants. It is described in a pamphlet issued by the U.S. Department of Agriculture in October 1940. Pupils and teachers used their own local land as text-book. They walked over the land and with their eyes learned to recognize the symptoms of misuse, to discover the causes, and to work out the principles of good use. A miniature whirl of dust led to the study of wind erosion and the Dust Bowl. The results of a flood and the loss of valuable cotton land led to the study of the watershed, its inter-relationships and the delivery of water from a forested area to the irrigated land below.

Owing to the war I have not as yet been able to procure the pamphlet itself, but I have read a review in *Indian Farming*, January 1942, which quotes verbatim from the pamphlet. It is so important and encouraging that I am reproducing the quotation in full.

'Basic concepts and bodies of subject matter were needed -- an understanding of the water cycle, the behaviour of the soil and water, the growth of vegetation. These were observed and understood and related to the daily life of human beings. Children gained some understanding of the hydrologic cycle in the simple story of the raindrop. Grass as a necessary food for livestock was known to even the smallest child in the south-west. How grass grew, how it reproduced, how over-grazing and trampling destroyed it, led quite logically to such statements as: "The cowboys should not let the cattle eat in one place too long." Sustained use of timber on forest land was expressed as the necessity for large trees, middle-sized trees, and little trees. Human use, human needs, human plans and solutions, were the core of each study.

'Children have a way of talking about matters that really interest them. Visits by pupils to demonstration areas have led to visits by parents. Parents have written letters to schools expressing their interest and pleasure upon learning that the children are studying land use. In sections where this type of education was going on, the technical men reported an added interest in the districts and a great facility in obtaining

agreements' (presumably for the better use of land and water by farmers and local authorities).

'The educational superintendents, supervisors, departments of education lent every facility, advised, took over where possible. The technical staff of the Soil Conservation Service conducted tours, learned to adapt their language to children's understanding, frequently wrote for us expositions in lucid, simple language. The material on human surveys, from our section of conservation economics, supplied information about the population, its use of land, its economic and social problems. Teachers, recognizing that soil conservation was of great interest to their community, that it helped in the vitalizing and socializing of the whole school programme, threw themselves into the programme with originality and eagerness.

'Our brief experiment has shown that land planning and use has an immediate interest for every school, and that teachers, pupils, parents, and State officials are eager to have a part in it. It is one of the great problems before us to-day. It has to do with subsistence, with food, clothing, shelter, taxes, and with many other problems which are a daily part of the home, community and the nation.'

Everyone concerned, it must be noted, becomes interested. It is a call to all from their very origin itself, and each man, woman and child, all creatures of the earth, eagerly respond to it. *It is a construction of the children's minds and a reconstruction of their elders' minds in terms of the soil*.

Mr. Bennett sums up his survey of the soil of the United States with these fateful words:

'After 4,000 years of building dykes and digging great systems of canals, the Yellow River broke over its banks and brought death to a million human beings during a single great flood. During one flood that great river, known in China as "the scourge of the sons of Han", changed its channel to enter the sea 400 miles from its former mouth.

'No one, of course, wants anything remotely like this to take place in this country, but "coming events cast their shadows before". That the greatest flood of which we have reliable records came down the Mississippi in 1927 was a prophetic event. G. E. Martin's statement about erosion as an enemy to agriculture -- "It is very unlikely that any other industry could suffer such losses and survive" -- is prophetic. That bare land, at the Missouri Agricultural Experiment Station, was found to be wasting 137 times faster than land covered with blue grass on a slope less than 4 per cent gradient is prophetic. That many millions of acres of cut-over land lie bare and desolate and exposed to the ravages of fire and erosion, with but pitifully little done towards reforestation, is prophetic. That minimum estimates show that the rate of plant-food wastage by erosion is twenty-one times faster than the rate at which it is being lost in crops removed, is prophetic.

'These shadows are portents of evil conditions that will be acutely felt by posterity. Shall we not proceed immediately to help the present generation of farmers and to conserve the heritage of posterity?

'The writer, after twenty-four years spent in studying the soils of the United States, is of the opinion that soil erosion is the biggest problem confronting the farmers of the nation over a tremendous part of its agricultural lands. It seems scarcely necessary to state the perfectly obvious fact that a very large part of this impoverishment and wastage has taken place since the clearing of forests, the breaking of the prairie sod, and the over-grazing of pasture lands. A little is being done here and there to check the loss -- an infinitesimal part of what should be done.'

These words did not fall on deaf ears. The President and Congress were deeply stirred and five years after the publication of Circular No. 33, the Tennessee Valley Authority took control of the valley of the Tennessee River and its tributaries, an area belonging to seven different States and of no less size than that of England and Scotland. This was the first answer of the Government of the United States to the question of the Circular: 'Shall we not proceed immediately to help the present generation of farmers and to conserve the heritage of posterity?' It was the first radical attack on the 'little that is being done here and there to check the loss -- an infinitesimal part of what should be done'.

To help the understanding of this great project, it is advisable to recall how in Tanganyika, under the guidance of Sir Donald Cameron, in order to avoid the erosion following upon the wholesale destruction of forests harbouring the tsetse fly, geologists, plant ecologists and water surveyors were called together to fit farmers in a manner understood by them to *the local character of the water supply as a whole*. Each river with its catchment area was made into a native-governed entity, and twenty-six such entities combined in one Union.

What the tsetse fly forced upon the discerning mind of Sir Donald Cameron, the devastation and poverty of the Tennessee River area forced upon the mind of the great President of the U.S.A., Mr. Roosevelt, and a strong following of members of Congress. The story has been told with a comprehensiveness worthy of the theme by the Chairman of the T.V.A., Mr. David Lilienthal, in his book, *The Tennessee Valley Authority*, 1944.

The story begins with the natural unity of the Tennessee Valley area, with its forested catchment areas of mountains and valleys, and the varied and interlocking animal and vegetable life they maintained. The forest-covering protected the soil against heavy rainfall, let the rain-water filter through the soil and return by the clear Tennessee River to the Mississippi and the sea.

Then came the White Men, lords of creation and of the negroes, who accompanied

them. They surveyed the land and found it suitable for two good money crops, cotton and tobacco. There were also many fine, saleable timber trees upon the mountainous ridges and slopes; there were minerals worth smelting; there were swift, clear rivers, which, if harnessed by dams, would yield electric power for the machines of the manufacturies. These primeval mountains and valleys were full of promise in a land of promise. Men set to work, each individual or group for their several purposes, and so the primal unity of the valley was destroyed.

At first, the land lived up to the title, land of promise, but little by little, the land was abused and rebelled. The time came when the hill-farmers found their land scored with gullies, the farmers on the plains their fields coated with silt from floods. The exploiters of timber, neglecting afforestation, saw their stock depleted and barrenness take its place. Hard-wood fuel no longer was enough to serve the furnaces of the smelters of ore, and the fumes of their ovens killed even the thin vegetation which attempted to cover the deforested land. Finally, the owners of dams found their pipes blocked by the silt of murky floods, and electricity no longer leaping from the dynamos which the piped water drove. The river itself was thick with silt, local navigation upon it was destroyed and, in flood, farmland washed away. Each was an enemy to the other, and, before the Tennessee Valley Authority took over the whole valley, the inhabitants were the most poverty-stricken and backward of any people in the U.S.A. They were in the front rank of the eroders and devastators, to whom Mr. Bennett attributed the results of his twenty-four years' study of the soils of the U.S.A. The outlook was as ominous as it could well be. The sole hope was to alter the very principles and methods of the usage of the valley as a whole and reintroduce those of the unity of nature, which had been ignored and fragmented. This was the work which Congress allotted to the Tennessee Valley Authority on that momentous date, 18 May 1933.

In the brief space of ten years, the T.V.A. have erected sixteen dams, some of them amongst the biggest in the world, and taken over and modified the five existing dams, and made them into one system of regulation of the rivers under their central control. They have now become masters of the rivers and their floods, and in 1942, when torrents came raging down a large part of the catchment area of the mountains, they conducted them safely into controlled channels. They protected the Tennessee Valley as a whole and its 4,500,000 inhabitants. They have planted a million trees grown in their nurseries and locally suitable to the soil. They have introduced contour ploughing, terraced cultivation, farmers' woodland and a balanced economy of legumes, clover, rotations, pigs, poultry and cattle upon 20,000 demonstration farms, in the midst of the 225,000 farms with 1,350,000 people living upon them in family farms averaging 75 acres. They manufacture phosphates, discovered by their experts as the present-needed artificial manure, and Mr. Lilienthal calls it in results 'the almost magic phosphate'. They have, with their mighty dams, created cheap electric power which gives each person 2,400 kilowatt hours compared to the average of the U.S.A. of 1,530 kilowatt hours, or 120,000,000,000 man hours for a single region. This has increased heavy and light industries, and, as a war consequence, it was largely because of this power that, in 1943, the U.S.A. was able to build its huge fleet

of bombers for use in Europe and the South Pacific. They have made a stretch of 464 miles of the river navigable with a depth of six feet and they will soon have a stretch of 650 miles with a depth of nine feet. Lastly, the number of fish in the river and its reserves has been increased fifteen times.

To effect these great harmonizing practices, the T.V.A. had to possess new harmonizing principles. They had to regard the inter-relation and independence of the different factors of nature in place of seeing nature as a battle in which each living type is set in open and secret enmity to other types in the bitter struggle for survival and priority.

Mr. Lilienthal illustrates and discusses, in a variety of aspects, the change which was necessary, not only in Congress itself, but in every sentient inhabitant of the Tennessee Valley. Here are some few of his words:

'Congress in creating the T.V.A. broke with the past. No single agency had in this way ever been assigned the unitary task of developing a river so as to release the total benefit from its waters for the people ... The T.V.A. Act was nothing inadvertent or impromptu. It was rather the deliberate and well-considered creation of a new national policy. For the first time in the history of the nation, the resources of a river were only to be "envisioned in their entirety"; they were to be developed *in that unity with which nature herself regards her resources* -- the waters, the land, the forests together, a "seamless web" -- just as Maitland saw "the unity of all history", of which one strand cannot be touched without affecting every other strand for good or ill.

'Under this new policy, the opportunity of creating wealth for the people from the resources of this valley was to be faced as a single problem. To integrate the many parts of that problem into a unified whole was to be the responsibility of one agency. The Tennessee Valley's resources were not to be dissected into separate bits that would fit into the jurisdictional pigeon-holes into which the instrumentalities of government had by custom become divided. It was not conceded that at the hour of creation the Lord had divided and classified natural resources to conform to the organization chart of the federal government. The particular and limited concerns of private individuals or agencies in the development of this or that resource were disregarded and rejected in favour of the principle of unity. What God had made one, man was to develop as one.'

The T.V.A. controls and bears the responsibility of the dams, the electric power, advice to the farmers, the fitting of industry to the whole, and general supervision and planning. Otherwise the greatest possible share has been given to the people of the valley by decentralization. 'A man wants to feel that he is important' is the maxim that directs this. 'The very essence of the T.V.A.'s method in the undertaking was at every hand to use directly, and to encourage and stimulate, the broadest possible *coalition* of all forces. Private funds and private efforts, on farms and in factories; state funds and state activities; local communities, clubs, schools, associations, co-operatives --

all have had major roles. Moreover, scores of federal agencies have co-operated' -- here a list of twenty is given -- 'the list, if complete, would include most national agencies.' The farmers themselves decide as to which farms shall be demonstration farms. The distribution of electric power is directed by the farmers, the industries, the municipalities, the States. The experts live amongst the people and are one with them. Labour is take primarily from the people of the valley; others chosen by merit are directed to expert work. No inducements are allowed to industries located in other regions to move to the Tennessee Valley.

Responsibility is distributed. The T.V.A. management is responsible to Congress, yet it is a separate authority, and its separation underlined in that neither its management nor its staff are permitted any share in politics except that of voting. The same separation is aimed at between the management and the staff; its members are encouraged to act and take responsibilities and not worry about mistakes. A like relation exists between T.V.A. and local bodies and associations, who are given and readily accept action and responsibility for their localities. Mr. Lilienthal himself terms it *Democracy on the March*.

The results have awakened the keenest interest, not only in the United States itself, but in other countries of the world, An impoverished and fear-stricken people in ten years have become prosperous, confident, well fed, well clothed. They are happier and better citizens.

One principle of service to the soil is missing from Mr. Lilienthal's book, the rule of the return of what is taken from the soil, after use, to the soil, by which, in particular, the Chinese have maintained their soil for so many centuries. There is one oblique reference to it in the statement that, if cotton-seed oil-mills made money, Tennessee cattle could be fed with the cotton-meal cakes they now export for sale. If they did this, 'as much as 80 per cent of the fertilizing value of the meal would be returned to the soil rather than continuously drained by export'.

Otherwise, the T.V.A. is a wonderful re-discovery of almost forgotten laws. How great this re-discovery may become, we shall now see in the story of a kingdom in Europe, which was, one might say, except for electric power, all Tennessee Valley and more.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 21

A Kingdom of Agricultural Art in Europe

It is refreshing -- and an essential restoration of the mind -- to turn from the dismal tale of farming under modern civilization and to review in its place a kingdom of agricultural art in western Europe. Such a kingdom can be found, but one has to go back a thousand years to find it. Further, apart from this long interval of time, there are other distances between this great agricultural society and the society of modern Europe. The race which directed this society is no longer to be found in Europe. Moreover, the religious faith which directed it is now only to be found in a few mountainous areas of eastern Europe. In its racial and religious characteristics, then, this society was strange to Europe, yet, in spite of this strangeness, perhaps because of it, it did for a period *attain to a fullness of civilization not reached by any other European people*.

This kingdom was that of the Arabs in Spain, which began with their invasion under Tarick in A.D. 711 and came to an end with the fall of Granada in 1472. Its period of harmony by no means extended for the whole of this term of seven and a half centuries.

The story of its achievements has been related by Mr. S. P. Scott in the three large volumes of his *History of the Moorish Empire in Spain,* published in Philadelphia in 1904, with a wealth of detail collected during a period of 'more than twenty years' in which 'this work engaged the attention of the author'. Particularly notable is the account in the thirtieth chapter of the agriculture on which this flourishing empire was based, and by which it supported a population believed greatly to exceed that of the united populations of England, France, Germany and Italy of that time. The figures given are some 15,000,000 to 20,000,000 for the four countries compared to some 30,000,000 in Arabic Spain.

The account of this wonderful agriculture existing in the Dark Ages of the rest of

Europe will be so strange to many readers, that they may feel that it is beyond the range of their credibility. The reason of this is that in English education the influence of Arabic culture is entirely left out. We are taught a lot about the Greeks and Romans, but nothing about the Arabs, as intellectual leaders of Europe.

Mr. Scott himself is well aware of the special educational default with which we are now concerned. He begins his thirtieth chapter with some bitter words, to show that he anticipated the incredulity with which his account would be met. 'In all the vast domain of historical inquiry', he wrote, 'there is probably no subject which has been treated with such studied neglect, with such flagrant injustice, as the civilization of the Arabs in the Spanish Peninsula. Its story has been written in the majority of instances by the implacable enemies of those who founded and promoted it. Theological hatred has lent its potent aid to the prejudice of race and the envy arising from conscious inferiority to deny or belittle its achievements.' Of how bitter this theological hatred could be a single example must suffice. Eulogius, a learned Spanish priest, discovered by his studies or invented the knowledge that Mohammed announced to his followers that three days after his death he would be raised by the angels to heaven; 'instead of this, dogs devoured his rotting corpse'. This example is taken from the well-known book of S. Khuda Baksh on *Islamic Culture*, 1905. When one thinks of the reverence with which Mohammed spoke of Jesus in the Koran and the same reverence which he transmitted to his followers, one can see on which side the bitter religious hatred lay.

Consequently, in view of this neglect and prejudice, Mr. Scott, in a list of 'Authorities consulted in the Preparation of this Work', gives no less than seven hundred and three, covering fourteen different languages.

Some of these numerous books are concerned with the Arabic culture and history as a whole. In the sphere of science and thought for example, William Lecky, in his *History of Rationalism*, 1865, paid this tribute to the Arabs: 'Not till the education of Europe passed from the monasteries to the universities, not till Mohammedan Science broke the sceptre of the Church did the intellectual revival of Europe begin.' Mr. John William Draper, in *A History of the Intellectual Development of Europe*, 1875, wrote in the same strain. A more recent writer than Mr. Scott, Mr. Robert Briffault, in *The Making of Humanity*, 1919, finally summed up the relation of the Arabic Sciences to those of Europe in the following words: 'The debt of our science to that of the Arabs does not exist in startling discoveries or revolutionary theories ... Science owes a good deal more to Arab culture, it owes its existence ... What we call science arose in Europe as a spirit of inquiry, of new methods of investigation, of the method of experiment, observation, measurement, of the development of mathematics in a form unknown to the Greeks. That spirit and these methods were introduced into the European world by the Arabs.'

One need not, therefore, be surprised that these same Arabs produced in the homeland of Irak, in Spain and elsewhere a great system of farming on which to support their

brilliant civilization. Many of the books quoted in Mr. Scott's list bear testimony to their farming art. I will confine myself, however, to coupling the quotations from two well-known French authors in his list. One is from Monsieur Gustav le Bon's *La Civilisation des Arabes*, 1884, 'The Arabs had even a greater aptitude for agriculture than for letters and arts. What means of irrigation are now found in Andalusia were made by them'; the other from Monsieur Sédillot's *Histoire Générale des Arabes*, 1877: 'In short they had irrigated and cultivated the land so excellently that it was befitting to call Andalusia a garden.' Mr. Martin Hume, writing three years before Mr. Scott and not quoted by him, summarized the farming art of the Spanish Arabs in these words: 'Agriculture and horticulture were developed to an extent never heard of before.'

Mr. Scott also gives in his list original works on Spanish farming. One of these works that escaped the attempted total destruction of the literature of the Arabs by their fanatical conquerors is *The Book of Farming*, by Ibn-Al-Awam, or to give him his full Arab name, Abu Zackaria Yahya Bin Mohammed Bin Ahmed Ibn Awam, who lived in Seville in the sixth century of the Mohammedan era. Mr. Scott quotes him in his list under the French translation of his work, *Le Livre de l'Agriculture*, 2 vols., Paris, 1866. This book was also translated into Spanish in 1802, and into Urdu in 1927, in two volumes in each case. It was not translated into English at the time of Mr. Scott, nor, as far as I know, has this grave omission in English scholarship yet been corrected. The Arabic MSS., however, repose in the British Museum Library, as well as in the libraries of Leyden, Paris and the Escorial.

Ibn-Al-Awam also has his list of one hundred and seven authorities upon the varied aspects of farming, and, since the Arabs were great translators, he quotes freely not only from Arabic writers, but from Greek, Latin, Persian, Nabathean and other agricultural experts, as well as experts on the allied subjects, botany, zoology, chemistry, mechanics and meteorology, etc. His translator into Urdu, moreover, emphasizes that he was a very cautious student, a true scientist, in short. This is what his translator writes: 'The peculiar quality of this book is that, whenever the author quotes the statement of an expert, he first tests it by personal experiment. Where he had not the opportunity to verify a statement by experimentation, he tells his readers that, though he has been unable to do so, he has such faith in the veracity of his informant, that he has copied his statements into his book. This precaution which is absent in other books, has greatly increased the value of the work of Ibn-Al-Awam.' A very reliable man, then, is this Spanish-Arabic scholar.

Mr. Scott himself gives the following epitome of *The Book of Farming*: 'The great work of Ibn-Al-Awam, of Seville, a vast monument of industry and erudition embracing every conceivable branch of the subject, shows to what extraordinary perfection the science of agriculture had been carried in the twelfth century by the Spanish Mohammedans. It treats, in a comprehensive and exhaustive manner, not only of the methods found by the experience of centuries to be the best adapted to the sowing and harvesting of grain, to the planting and cultivation of orchards, to the

propagation of edible and aromatic plants; but it also, with infinite minuteness of detail, describes the breeding and care of every species of domestic animals, their qualities, their relative excellence, their defects, their habits, their diseases. It discourses at length upon the different breeds of horses and upon the rearing of that useful animal so prized by the Arab. It explains the details of artificial incubation, a process borrowed from Egypt. It directs how to produce in geese the abnormal hepatic conditions which induce the *foie gras*, that artificial delicacy so dear to the epicure, and a thousand years ago, as to-day, an invaluable adjunct to fashionable gluttony. It teaches the different methods of cooking and the preparation of various confections, jellies, syrups and sweetmeats of every description. The manufacture of wine, so rigidly forbidden to the Moslem, and whose immense consumption had already, in the time of the Khalifate, scandalized the pious, is detailed in all its stages in this remarkable book. In it are given recipes for cordials of many kinds, cooling beverages and hydromel. It also prescribes the rules by which the household of the farmer should be governed, and defines the reciprocal duties of employer and employee. In every operation of rural life and domestic economy, it enforces by repeated admonition the necessity for cleanliness, system and order.'

I have dealt at some length with the credibility of Mr. Scott's account of the Arabic agricultural system in Spain, because, though in the Industrial Era, which began some hundred and seventy years ago, we have made vast strides in the sciences and have far outstripped their initiators the Arabs, we have, at the same time, not advanced but dangerously receded in the recognition that our complicated civilization must for our safety and prosperity be founded upon the soil and its preservation. Where the Arabs accomplished a success and brilliancy in all the factors of social life, we have changed our agriculture into a Rape of the Earth. It has lost its national meaning and the love and reverence of the people it supports. To convert readers in this contention, I saw no better way than to acquaint them with A Kingdom of Agricultural Art in Europe and An Historical Reconstruction, and convince them of their reality.

The agricultural system of the Moors in Spain was, writes Mr. Scott: 'the most complex, the most scientific, the most perfect, ever devised by the ingenuity of man. Its principles were derived from the extreme Orient, from the plains of Mesopotamia, and from the valley of the Nile -- those gardens of the ancient world where, centuries before the dawn of authentic history, the cultivation of the earth had been carried to a state of extraordinary excellence. To the knowledge thus appropriated were added the results obtained from investigation and experiment, from the introduction of foreign plants; from the adoption of fertilizing substances; from the close and intelligent observation of the geographical distribution and climatic influence.'

No cultivators had a more profound knowledge than this people of the value of water. They, like the great riverine peoples, from whom they derived so much knowledge, realized that *the proper use of water was civilization. Without its just and conservative distribution, the true justice and magnanimity of civilization do not really exist.* By the art of distributing water 'a considerable portion of the country

which had never been subjected to tillage because of its aridity became suddenly metamorphosed, as if by the wand of an enchanter. Barren valleys were transformed into flourishing orchards of olives, oranges, figs and pomegranates. Rocky slopes were covered with verdant terraces. In districts where, according to ancient tradition, no water had even been seen, now flowed noisy rivulets and broad canals. Where marshes existed, the rich lands they concealed were drained, reclaimed and placed under thorough cultivation. On all sides were visible the works of the hydraulic engineer -- which supplied the necessary moisture to the fields by every device then known to human skill -- the reservoir, the well, the sluice, the tunnel, the siphon, the aqueduct.'

Water was lifted to higher levels by Persian wheels, of which in a few square leagues there might be five hundred, some with diameters of seventy feet. Grades were ascertained by the use of the astrolabe. 'The public works constructed for irrigating purposes were on a gigantic scale. The artificial basin near Alicante, elliptical in shape, is three miles in circumference and fifty feet deep; the dam at Elche is two hundred and sixty-four feet long, fifty-two feet high, and a hundred and fifty feet wide at the bottom; that over the Segura, near Murcia, is seven hundred and sixty feet long and thirty-six feet in height. The aqueduct at Manesis, in Valencia, is seven hundred and twenty feet long, and is supported by twenty-eight arches. The principle of the siphon, familiar to the Arabs eight hundred years before it was known in France, was utilized to a remarkable degree in the Moorish hydraulic system. The length of the curve in the great siphon at Almonora is five hundred and seventy feet; the diameter of the latter is six feet, and it passes ninety feet under the bed of a mountain stream. The subterranean aqueduct at Maravilla, which waters the plain of Urgel, is a mile long and thirty feet in diameter; that of Crevillenta, north of Orkuela, is fifty-five hundred and sixty-five feet long and thirty-six feet in diameter. All of these underground conduits are cut through the solid rock. The masonry of the reservoirs is of the finest description, and the cement made use of has become harder than stone itself. Contingencies are provided for with some skill and foresight that no overflow occurs, and no damage ever results, even in the time of the greatest inundations. The excellence of construction of these massive works of Arab engineering is demonstrated by the fact that they have needed practically no repairs in a thousand years.'

The distribution of the water was governed by a peculiar code of laws, perfect familiarity with which was only to be obtained by those working for their livelihood under its direction. With a wise trust in local government, the execution of these laws was presided over by a Tribunal of the Waters, the members of which were chosen by the farmers themselves. This Tribunal saw that there was no waste; theft was heavily punished; disputes and violations of the regulations came under its jurisdiction. 'Judgment was rendered after consultation, and from it there was no appeal. The most exalted rank, the greatest wealth, the most distinguished public service, did not confer exemption from the jurisdiction of the court or affect the impartiality of its decrees. The noble was summoned to its bar with little more ceremony than the slave ... The wisdom of these regulations is demonstrated by their longevity.

'In the distribution of water the measurement was by volume, a certain quantity being allotted to a stated area during a given period of the day or night at intervals of ten to fifteen days. The sides of the canals were provided with flood gates, kept under lock and key, by which the adjoining fields could be submerged at the proper time. Drains carried the surplus back into the original channels, so that there was the least possible loss.'

Such was the way in which water was used so as to make a great society of people possible and durable. It is of profound significance, but it is seldom known by modern men of even wide education. Yet there is no knowledge more entirely needed by modern Europe. What is the use of a glutted treasury of knowledge, while it is, at the same time, *defective in the vital knowledge* which the Arabs possessed.

In the second great precept of the art of agriculture, the rule of return, the Arabs were as effective as they were in the knowledge of water. The same care and economy were observed in fertilizing the soil, which the requirements of a dense population never permitted to rest, writes Mr. Scott, and continues: 'Manure and dust were collected from the highways. The contents of sewers and vaults were preserved, desiccated, and, mingled with less powerful substances, were used to supply the impairment consequent upon incessant cultivation. Ashes, the burned and pulverized seeds of fruits, the blood and bones of slaughtered animals, all played an important part in the intelligent and systematic treatment of the rich and productive valleys of the south, whose surface, resting on an impenetrable subsoil of clay, required continued renovation. The curious and minute investigations of the skilled agriculturist had determined the best composts, the most advantageous modes of applying them, the kind of vegetation to which they were especially adapted.

'Manures were deposited in stone reservoirs contrived to prevent evaporation or leakage. Nothing was wasted; every substance available for the fertilization of crops was carefully preserved, the different varieties being separated and applied to such soils as experience had taught were most productive under their use.'

The third great precept of the art of agriculture was followed by the Arabs in the preference for independent small holdings. 'Unlike the policy adopted under the Roman and Gothic dominations, there were few large estates. The land was divided into small tracts, and for that reason was much more thoroughly tilled ... Every indulgence and encouragement was afforded by the laws to the Moorish cultivator. The independence so necessary to the successful prosecution of agricultural pursuits, he enjoyed to the utmost degree compatible with the social order. For the most part, he himself instituted the regulations of husbandry, which were enforced by magistrates taken from his class and of his own selection. His taxes were not oppressive. The productiveness of the soil, the equability of the climate, never permitted his labours to go unrewarded.'

A fourth was the use of terraced cultivation. 'In localities unfavourable to cultivation the deficiencies of the soil were supplied by untiring industry. Walls of ponderous masonry supported terraces where the very cliffs were made productive, and where only a bush or vine could be planted the narrow space was utilized. Not only water, but loam and fertilizing materials were brought from great distances.'

The cultivators were also encouraged to adventure upon new paths. 'The unrivalled excellence of the agricultural methods employed by the Spanish Mohammedans was, in large measure, due to their profound botanical knowledge.' Botanists were dispatched to Egypt, Mesopotamia, India, the East and every quarter of the globe, to collect seeds of useful plants and fruits for experimental cultivation. 'Gardens for the propagation of both native plants and exotics were established in the environs of all the great cities, and the results of intelligent observers were regularly tabulated for the public benefit ... In all the multifarious duties of his occupation the Moorish horticulturist possessed expert knowledge.' Owing to this scientific knowledge and the keen adventure of the naturalists, the Arabs introduced into Europe the strawberry, lemon, date, quince, fig, mulberry, banana, pistachio, almond, rice, sesame, buckwheat, spinach, asparagus, mace, nutmeg, pepper, caper, saffron, coffee, cotton, sugar-cane, though according to Dr. H. Hintze, in his book, *Geographie und Geschichte der Ernährung*, some few, such as lemons, quince, almonds and mulberries, appeared on the tables, if not on the fields, of the Romans at the time of the Empire.

Botanical knowledge and widespread education, shortly to be described, therefore combined to promote these excellent results. The treatises on agriculture and horticulture dealt with every aspect of cultivation. The cultivators were, thereby, made familiar with the movement of the sap, the difference of sex in plants, and the process of artificial fecundation. They invested plants with the conditions of activity and repose, of motion and sleep. They followed no less than eight methods of grafting and protected the grafts by ingenious devices from the injurious effects of the sun. They knew how to preserve fruits and grains in subterranean chambers hewn out of the rock. In all agricultural matters, in brief, knowledge was strengthened and widened by skilled agricultural literature.

There was the same skill and knowledge in the rearing of cattle and horses, in the breeding of sheep and the culture of bees, which attained to the highest degree of proficiency. The Arab horse lost none of its speed and endurance for being bred and reared in Spain. The abundant, silky fleece of the merino sheep was due to a peculiar method by which flocks were tended. Immense flocks were driven twice a year between the slopes of the Pyrenees and the plains of Estremadura, by which means they secured both fresh and continual pasturage and freedom from the droughts of summer and the storms of winter.

Lastly the love of flowers was a passion among the Spanish Muslims. Mr. Scott writes: 'As they were the greatest botanists in the world, so no other nation

approached them in the perfection of their floriculture and the ardour with which they pursued it.' Whether they were cultivated solely for their beauty and perfume or whether they also cultivated them, because, as has been seen in Chapter 16, they help in their especial way to preserve the cultivation of the soil, Mr. Scott does not say.

By this fine farming, the food of the people was provided, but, owing to varieties of climate and in spite of the great system of irrigation, bad years would occur. To secure the people against hunger at such times, the export of grain was forbidden -- as laid down in the Koran -- and the surplus of good harvests was deposited in granaries hewn in the rock. Forests of oak were also carefully preserved for the sake of their acorns, which furnished a coarse but nutritious diet at time of extremity, when famine otherwise threatened.

Such a wide and complete agricultural factor of a human life-cycle, as the Arabs of Spain created, must necessarily give a wholeness and health to the other factors of civilization. Consequently, in every other art, there occurred the same prosperity and excellence as those which distinguished the art of the soil.

Of their other arts, Mr. Scott writes with a fervour no less inspired by their adequacy than it is by the adequacy of the cultivation of the soil. He describes the organization of the traffic of commerce by land and by sea; the markets and fairs; the principles of equitable dealing in business transactions and in dealing with other nations, as laid down by Islamic law; the ports and the great centres of manufacturing and mercantile activity situated on the Mediterranean Sea; the silk factories and the factories of iron and copper utensils of Almeria; the potteries of Andalusia; the leather work of Cordova, the capital; the silks of Seville; the paper of Xativa; the steel of Toledo; the textile fabrics of Lusitania and Andalusia; the glass-work at Almeria, which was the teacher of later glass-work in Venice; the jewellers of Granada; the mats and basket work of Alicante; the mills of Murcia and Saragossa; the linens of Salamanca; the musical instruments of Seville; and the wines, the use of which scandalized the orthodox Moslem, to whom intoxicants of any kind were forbidden.

Above all these accomplishments of labour was the passion for literature and knowledge. The great monarchs of the great period, from A.D. 755, when Abd-al-Rahman I founded the Ommeyade Dynasty in Spain, to the death of Al-Hakem II in A.D. 976, were not only patrons of literature, but were themselves personally distinguished as authors. Abd-al-Rahman I himself, amidst a life of inexhaustible adventure, from prince to beggared outcast and from outcast eventually to king, was a real lover of literature and art, and a poet of unusual ability. He cultivated the public taste by periodical literary contests, and attracted the most accomplished scholars and poets to his side, not only by material rewards, but by his friendship and the engaging versatility of his comprehensive genius. Had Leonardo da Vinci lived in his time, he would have found the royal friend, worthy of his consummate genius, whom he sought for in vain in Italy and France.

The successors of this great man were worthy successors, indeed, one can hardly

believe how there came into being a series of monarchs, not of education only, but of that high degree of culture which alone can be promoted and nourished by an inward passion for it. Such men have filled thrones in many lands with great benefit to their peoples. But the Ommeyade Dynasty in Europe certainly was unique in the number of its monarchs of high culture. It reached its peak in the reign of the monarch regarded as the greatest of the Arab kings of Spain, Abd-al-Rahman III, and his son Al-Hakem II, the monarch who in himself represented the highest personal culture possibly reached by a monarch. 'The prominent features of the character of Al-Hakem', writes Mr. Scott, 'were his love of learning, his profuse but always judicious liberality, and his profound reverence for the doctrines of the Koran and the laws of the Empire. The few military operations he was called upon to direct showed no want of vigour, and suggested that in a less peaceful age he might have obtained the laurels of a successful general. His devotion to literature amounted to a passion. No monarch of whom history makes mention has equalled him in the extent of his knowledge or the number and diversity of his literary accomplishments.' He gathered together an unequalled library, which required forty-four volumes for the catalogue alone. 'With the contents of most of these works Al-Hakem is said to have been familiar, and, indeed, many of them were enriched by notes and comments written by his own hand. The title-page of each volume bore not only the name of the author, but also his genealogy, as well as the date of his birth and his death, all collected and preserved by the indefatigable industry of the royal scholar.' His prodigious memory; his powers of acquisition; his critical acumen; his talent for composition; and the capacity which could abstract from the administration of public affairs of a great monarchy sufficient time for literary undertakings -- that, under ordinary circumstances, could only be accomplished in a lifetime of constant study, are marvellous and incredible. For Al-Hakem was an historian of approved merit, as well as an impartial critic and a voluminous commentator. He wrote a history of Spain, now unhappily lost, which was considered a high authority in its time, and whose reputation was universally admitted to be independent of the prestige which it would naturally derive from the name and rank of its author. Such was his erudition that in knowledge on obscure points of genealogy and biography he was without rival, even in the learned court of Cordova; and his fund of historical information was so profound, and his judgment so accurate, that his opinions were respected and unquestioned by the most accomplished scholars of the Mohammedan world. As may be conjectured, a prodigious impulse was imparted to education by this extraordinary patronage of letters. The accumulated wisdom of Africa, Asia and Europe was to be found at Cordova ... Education was reduced to a system, whose regulations were enforced with military precision.' Linguists exhausted every source of knowledge. Not only did they translate the masterpieces of Greek and Roman literature, but they familiarized themselves with Persian, Chaldaic, Hebrew, Chinese, Hindu and Sanscrit works. This education and 'the absolute intellectual liberty which there existed was, indeed, considered a reproach by ignorant Moslems of less enlightened lands, who could not understand the association with heretics and the toleration of infidels; but in Spain, where a system of universal education had been established, and was enforced as well by law as by the influence of public opinion, this inestimable privilege was thoroughly appreciated'. Encouraged by the patronage of royalty 'the mental

development of the masses advanced with gigantic strides'. 'In Cordova alone there were 800 public schools frequented alike by Moslems, Christians and Jews ... There was not a village within the limits of the Empire where the blessing of education could not be enjoyed by the most indigent peasant.' Women joined in this advance. 'The exalted position occupied by women under the Arab domination in Spain gave them an influence and invested them with an importance, elsewhere unknown in the Mohammedan world.' Chemists, botanists, biologists, astronomers, mathematicians, physicians and surgeons lifted science to a level it had never previously reached in Europe. Engineers covered the land with roads, canals and public works; lastly architects brought into being the exquisite buildings, the palaces, colleges and mosques, which the religious fanaticism of the Christian conquerors later destroyed together with the libraries and their books.

In the education of this great period, the farmers had their full share. In all the principal towns there were schools of agriculture. From them the cultivators learnt to preserve fruits and to protect their fields against noxious insects. They learnt meteorology and could foresee atmospheric changes with effective accuracy. In all the multifarious duties of farming they possessed an expert knowledge. It was in this period and supporting it that 'agriculture was brought to such excellence as seemed to make any further improvement impossible'.

The best indications of Arabic Spain as a pro-life civilization are those of population. 'It has been estimated by competent authorities that the subjects of Abd-al-Rahman III numbered at least thirty millions. Great as was the extent of the metropolis, incredible as was her wealth, superb as were her environs, many of the other cities of the Empire, while they could not rival her power and grandeur, shared the enormously profitable benefits of a civilization in which Cordova enjoyed a well-deserved pre-eminence. The dominions of the Khalif included eighty municipalities of the first rank and three hundred of the second; the smaller towns were innumerable. Along the banks of the Guadalquivir alone stood twelve thousand villages. So thickly was the country settled that the traveller usually passed, in the space of a single day's journey, no less than three large cities in the midst of an unbroken succession of towns and hamlets. Nothing comparable with the opulence and splendour of the great provincial capitals was to be seen outside the Peninsula. Seville contained five hundred thousand inhabitants; Almeria an equal number; Granada four hundred and twenty-five thousand; Malaga three hundred thousand; Valencia two hundred and fifty thousand; Toledo two hundred thousand.'

The effect of the final expulsion in 1609 of the Moriscoes, Muslims who remained in Spain after the Christian conquest and were compelled to become converts to Christianity, is described by Buckle in his classic *History of Civilization in England*, 1861, in these words: 'The effects upon the material prosperity of Spain may be stated in a few words. From nearly every part of the country, large bodies of industrious agriculturists and expert artificers were suddenly withdrawn. The best systems of husbandry then known were practised by the Moriscoes, who tilled with indefatigable

labour. The cultivation of rice, cotton and sugar, and the manufacture of silk and paper were almost confined to them. By their expulsion all this was destroyed at a blow, and most of it was destroyed for ever. For the Spanish Christians considered such pursuits beneath their dignity. In their judgment, war and religion were the only two avocations worthy of being followed. When, therefore,the Moriscoes were thrust out of Spain, there was no one to fill their place; arts and manufactures either degenerated, or were entirely lost, and immense areas of arable land were left uncultivated. Some of the richest parts of Valencia and Granada were so neglected, that means were wanting to feed even the scanty population which remained there. Whole districts were suddenly deserted, and down to the present day have never been re-peopled.'

The population of Madrid, continues Buckle, fell from some 400,000 to 200,000; Seville's population decreased by three-quarters and her 16,000 looms dwindled to under 300; Toledo witnessed the disappearance of her silk manufactory, which employed 40,000 people, and upwards of 50 woollen manufactories shrank to 13; Burgos became deserted and lost everything but its name. In Buckle's grim words, 'Spain, numbed into a death-like torpor, spell-bound and entranced by the accursed superstitions which preyed on her strength, presented to Europe a solitary example of constant decay'.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 22

An Historical Reconstruction

The Islamic civilization in Spain, of which an account was given in the previous chapter, formed a significant part of what was, perhaps, the most remarkable reconstruction of mankind in history. An outline of it can best be given, if it is divided into three periods, that of its initiation, that of its institution, and that of its achievement.

The Initiation

The period of initiation was that of the life of its founder, the prophet Mohammed.

Mohammed was born in Mecca in A.D. 570 as a member of the leading tribe of Mecca, the Koraish. His father dying before he was born and his mother when he was six, he came under the tutelage of his grandfather, Abd-al-Muttalib. His grandfather died when he was thirteen, and he was then confided to the family of a poor but affectionate uncle, Abu Talib.

Mohammed grew up to be a quiet, meditative man, taking little or no part in public affairs, but by his humanity and justness earning for himself the name of The Trusty. Then, when over forty, upon a night of meditation, he heard a Voice commanding him: 'Cry: in the name of the Lord.' He obeyed and henceforth became a Messenger crying in the name of the Lord. In Mecca his message was to denounce the idolatry which constituted the religion of the people, and in its place to teach the worship of Allah, the one and only God. This aroused the fury of the Koraish against him and his disciples. The latter escaped to Yathreb, or Medina, the City of the Prophet, as it became named. Mohammed remained behind amongst his enemies. Discovering a joint plan to murder him, he also fled from Mecca to Medina. This Hegira or Flight took place in A.D. 622 and from it dates the Mohammedan calendar.

In Medina the religion he taught was simple. He preached that there was but one God, the unity of living things, the brotherhood of man, kindness to women and children, gentleness to animals, alms for the poor, and the value of prayer.

His preaching and person won the hearts of the people of Medina. He was made the Chief Magistrate, with power to carry into practice what he taught. At that time, writes Ameer Ali Syed, in *A Short History of the Saracens*, 1900, 'there was no law or order in any city of Arabia'. Medina itself was torn by a feud between two principal tribes. Mohammed reconciled the two tribes, abolished all tribal distinctions, and grouped the inhabitants of Medina under one generic name, Ansar or Helpers. He issued a Charter, by which all blood-feud was abolished and lawlessness repressed. Equal rights were granted to the Jews, of whom there were many in and about Medina, and who, on their part, bound themselves to help the Moslems in defending the city if attacked.

The next step in his mission was to unite the peoples of Arabia, but in this he was hindered by the bitter enmity of his own tribe, the Koraish of Mecca. The Meccans, in the first year of the Hegira, attacked the Moslems and were defeated. In the third year, the Meccans, under the command of Abu Sufian, the son of Ommeya, whose descendants were to become the Ommeyade Caliphs of the early Arabic Empire, were successful, but their losses were so great that they did not venture to attack Medina itself. In the fifth year of the Hegira the Meccans with an army of 10,000 besieged Medina, but, in spite of the treachery of the Jews, who took the side of the Meccans in the siege, the Moslems, owing to the defensive skill of Mohammed, were victorious. This victory freed Mohammed for his work; its fame and the prestige, which Mohammed gained, both as teacher and as general, led to his acknowledgement by tribe after tribe throughout Arabia. In the seventh year of the Hegira, the Meccans attacked one of these tribes. Mohammed gathered together an army of 10,000 men and entered Mecca as a conqueror. Nevertheless, at the sight of the city and of familiar but hostile faces, he treated the Meccans as brothers. Excepting four criminals, all were forgiven and accepted Islam. Mohammed himself shattered the idols of Mecca with the cry: 'Truth is come, darkness departeth'.

The ninth year of the Hegira, known as the Year of Deputations, witnessed the general acceptance of Islam by the tribes of Arabia. Mohammed dealt with them in the same liberal spirit as he had shown to the Meccans. 'A written treaty guaranteeing the privileges of the tribe was often granted,' writes Ameer Ali, but in order to promote the change of heart that was Mohammed's especial mission, 'a teacher invariably accompanied the departing guests to instruct the newly converted people in the duties of Islam, and to see that every evil practice was obliterated in their midst'.

Mohammed had now fulfilled his mission by uniting all Arabia. He died on 8 June A.D. 632, at the age of sixty-two.

The actions, character and teaching of Mohammed made so profound an impression

upon his contemporaries that the total effect of his personality formed the basis of the Islamic law and civilization. The chief source of that law was the Koran, but the Koran did not cover all the growing needs of the Arabic Empire that so swiftly followed upon the death of Mohammed. Hence, in addition to the Koran, every detail that could be recalled by contemporaries and especially by those most near and dear to him and with whom it was his habit to consult in questions not actually revealed to him was carefully recorded. In Medina, he had been the final judge, the spiritual leader of religion, and the temporal leader, with the duties and powers of an essential sovereign, given to him, in complete trust in The Trusty, by the people. Hence, in the formation of the Islamic law, his inspired utterances in the Koran, his discourses, his decisions after consultations, his expressed approvals, his tacit agreements by gesture, his judgments, his actions, were all brought into service as guides of conduct for pious Moslems by the Islamic legalists and religious Caliphs. From them were derived the fundamental or fixed laws, fundamental and fixed because they were derived from the Prophet of God.

Islamic law controlled every aspect of the life of a Moslem, but for simplification of this vast subject it was divided into categories, ranging from the few obligatory or prohibited things as determined by the Koran and the *Hadith* or the traditions of the Prophet, to the limited number of the approved or disliked, and the unlimited number, which were left to everybody's common sense. By-laws were made by the legalists to adjust changes and circumstances, which time brought about, but they were kept within the orbit of the fundamental laws. Only in cases of extreme emergency could a fundamental law be abrogated, and then only for the duration of the emergency.

Never, therefore, in history has any man been so intimately identified with a civilization as was Mohammed with that of Islam, which endured as an empire until the sacking of Baghdad by the Tartars six and a quarter centuries after the death of Mohammed. As this civilization produced a truly remarkable reconstruction of mankind in agriculture, manufacture, trade, knowledge, art and other departments of human society, the *spirit* of Mohammed's precepts become peculiarly important at a time such as the present, when a further reconstruction is so urgently needed.

This spirit has been admirably told for readers of English by Ameer Ali Syed, in *The Spirit of Islam*, 1922. Its chief character, to my mind, can be put in homely language: Mohammed was the first statesman to introduce *decency of human conduct in every department of society*. He left no class of human beings out of his thought. He was, I feel, unquestionably the greatest humane, constructive statesman in history.

Ameer Ali, however, does not give a very explicit account of Mohammed's attitude to war, which is of such vital concern to men in these days. So, before taking up his review, it will be well first briefly to consider Mohammed's attitude to war. It has been admirably told by Mr. Marmaduke Pickthall in an article entitled 'War and Religion' in the *Islamic Review Book Series*.

Firstly, Mohammed recognized the necessity of war in the collective life of mankind, for the reason that: 'If it had not been for Allah's repelling some men by others, the world would have gone to badness; but Allah is a lord of kindness in creation' (Koran). To repel bad men was, therefore, the reason for going to war and it was for this reason that every capable Moslem must be prepared to go to war, if called upon to do so. It was not conscription, but a sacred duty, provided that the war was a holy war or *Jihad*. Then 'fighting is enjoined upon you, and it is a thing hateful to you. But it may be that you hate a thing which is good for you, and it may be that you love a thing which is bad for you; God knows best and you do not know,' said the Koran.

War was enjoined against grave injustice, 'to defend the weak man, and for women and for children, those who say: "Our Lord, take us out of this city whose people are oppressors. Oh, send us from Thy presence a befriender; oh, send us one who can help us!"' (Koran). Retaliation against aggressors was commanded. 'Kill them wherever you find them and drive them out of the places from which they drove you out. Persecution is more cruel than killing. And do not fight them round the sacred mosque, unless they attack you there. And if they do attack you, kill them. Such is the reward of graceless people' are the words of the Koran. But on no account were the Moslems to be the aggressors. 'Fight in the way of Allah against those who fight against you, but do not originate hostility. Truly Allah loves not the aggressor.' By the spread of Islam, therefore, Mohammed hoped to abolish the brutality or even existence of war.

Throughout the Koran, writes Mr. Pickthall, 'the word "treaty" means a sacred compact, a solemn covenant, which to break is impious,' and he adds, from a wide knowledge of Islam not possessed by any other Englishman: 'With Islamic nations, treaties have always had this sacred character. I cannot recall a single instance of a Muslim power ever consciously breaking a treaty, though they have the right to throw the treaty back if they fear treachery.' Actual treachery was to be treated with the severest punishment, such as was inflicted upon the Jewish traitors of Medina.

Lastly, Moslem soldiers were forced to observe correct or decent conduct. The sanctity of the soil was to be respected. Moslems, invading a country, were forbidden to destroy fields of corn, or palms, or any fruit trees, or to slaughter cattle except in case of urgent need. 'Destroy not the means of subsistence,' was Mohammed's command. Similarly 'the quiet people', as the old Moslem jurists called the unarmed inhabitants, were to be respected. They were not to be killed; they were not even to be molested; neither they nor their houses were to be plundered. 'Plunder is no better than carrion,' said the Prophet. That, however, which was left on the field of battle, was lawful booty. Finally, enemy combatants were to be respected. 'If they desist (from fighting), then (there should be) no hostility except to evil-doers' (Koran). For the evil-doers, there was the law of retaliation. As they had done, so should it be done to them.

Now, under the guidance of Ameer Ali, we will review Mohammed's relation to

conquest. In this no statesman ever used the quality of clemency to those forced to acknowledge his authority with more effectiveness. To those who accepted Islam, he ordained all the privileges and freedom associated with that sacred name, meaning as it does Surrender to Allah or God. To those who submitted, but wished to keep their own faith other than that of idolatry, he presented the utmost tolerance. They were allowed to pursue their own customs and their religious faith, provided they paid the not onerous taxes and obeyed the other civic duties imposed upon them by their Arabic rulers. They were exempted from military service, paying an especial tax in lieu of it. Their lands were not taken from them. The precedent of this tolerance was set by the Charter, which the Prophet granted to all Christians in the sixth year of the Hegira. The spirit of it was Christian in its best sense, since Mohammed always regarded Jesus as the Teacher most akin to him in time and teaching. 'In this Charter', writes Ameer Ali in his *History of the Saracens*, 1900, 'the Prophet undertook himself, and enjoined on his followers, to protect the Christians, to guard them from all injuries, and to defend their churches, and the residences of their priests. They were not to be unfairly taxed; no bishop was to be driven out of his bishopric; no Christian was to be forced to reject his religion; no monk was to be expelled from his monastery; no pilgrim was to be detained from his pilgrimage; nor were the Christian churches to be pulled down for the sake of building mosques or houses for the Moslems. Christian women married to Moslems were to enjoy their own religion and not be subjected to compulsion or annoyance of any kind on that account. If the Christians should stand in need of assistance for the repair of their churches or monasteries, or any other matter pertaining to their religion, the Moslems were to assist them.'

In pre-Mohammedan Arabia, the women were the chattels of the men. 'In both the Empires, the Persian and the Byzantine', writes Ameer Ali in *The Spirit of Islam*, 'women occupied a very low position in the social scale. Fanatical enthusiasts, whom Christendom in later time canonized as saints, preached against them and denounced their enormities.' Then, when the family, and with it the whole social fabric, was falling to pieces on all sides, Mohammed introduced his reforms and 'enforced, as one of the essential teachings of his creed, "respect for women".'

Mohammed raised women to a legal and economic equality with the stronger sex. His precepts and the eventual fixed laws on divorce were strikingly just to women, though he himself expressed his strong disapproval of divorce, in that it brought evil and hardships upon the children. So also, as regards property, the rights which he gave to woman, in spite of the later deterioration of their status under Persian and Byzantine influence, were and are such as even now have not been fully attained in most Western countries. Mohammed's aim was to enable women to become individuals in the State, and this independence he gave them by allowing them to own property, to possess that which they earned by their own efforts, to have their share in the widely spread inheritances left by their fathers, husbands and other near kinsfolk, to be given marriage settlements from their prospective husbands in their favour, and to possess the right to act in any legal matters concerned with these rights without any

intervention on the part of their fathers or their husbands. To the best of his power -- and his power was great in spite of the opposition of the times -- he was the emancipator of women.

Following his precept of the brotherhood of men, Mohammed strove for the betterment of the slaves. Slaves formed a large part of every society of the time. 'The, Church itself held slaves', writes Ameer Ali of the Christian attitude to slavery, 'and recognized in explicit terms the lawfulness of this baneful institution.' Though Mohammed himself abhorred slavery and taught that no action was more acceptable to Allah than the freeing of a slave, he did not attempt the total abolition of a custom so deeply rooted in the economic life of society. What he did do was to infuse the whole question with the spirit of brotherhood and thereby he entirely altered the character of slavery. He provided funds out of the public treasury to enable slaves to purchase their freedom without interference from their masters; he ordered that they could purchase their liberty by the wages of their service; in many ways he opened up the path of liberty. He ordained decency of conduct to slaves, who were to be treated by their owners with the same kindness that they showed to kindred and neighbours. The slave mother was not to be separated from her child, nor the father from the son, the husband from the wife, the relative from the relative. There was to be *equality of food* between slaves and their owners, and equality of dress. They were only to be addressed in terms of affection and not with words implying a.degraded position. 'The whole tenor of Mohammed's teaching', says Ameer Ali, 'made "permanent chattelhood" or caste impossible; and it is simply "an abuse of words" to apply the word slavery, in the English sense, to any status known to the legislation of Islam.' By abolishing all distinctions of race and colour, black and white, citizens and soldiers, subjects and rulers, Mohammed gave an equal humanity to slaves. 'In the field or in the guest-chamber, in the tent or in the palace, in the mosque or in the market, they mingled without reserve and without contempt.' In so far then as slavery continued, Mohammed made it a *social condition within the brotherhood of man*. Moslem slaves could rise to high positions in a state. Many were to become kings; others became governors of provinces, generals, famous men of learning and religion.

Dealing with the chief of economic difficulties, that of the distribution of wealth so as to avoid the extremes of the very rich and the degraded poor, Mohammed displayed the rarest wisdom of statesmanship. This was evidenced in the *Zakat*, the rules of inheritance, and the abolition of usury. The story of that great economic work has recently been retold by Mr. M. Hamidullah, in the second number for 1926 of the quarterly, *Islamic Culture*, in an article entitled 'Islam's Solution of the Basic Economic Problems.'

Mohammed, in the Koran, frequently declared that it is for God to provide a livelihood to every creature: 'We have given you power in the earth and appointed you therein a livelihood.' It was the duty of the State, by means of the Zakat, or Growth-tax, to ensure this livelihood. Zakat was a tax on all property owned beyond a certain maximum and was meant, as Mohammed said: 'To be taken from the rich

among them in order to be given to the poor.' And if the treasury was not sufficient to supply the needs of the poor, the ruler could compel the rich to do so. The poor man he defined as one 'who finds not the wherewithal to make himself independent'.

Zakat was of two kinds, Sadaqah, or the tax on the growth of capital goods and the Tithe or tax on the surplus produce of the soil. 'The Zakat is only for the poor and needy' was the command of the Koran, 'for those whose hearts are to be reconciled' (men who had become impoverished by accepting Islam) 'and to free the captives and debtors, and for the cause of God, and for the wayfarer; a duty imposed by God.'

Mr. M. Hamidullah points out some of the particular virtues of this tax and the balance it effected between rich and poor. It gave the workers a certain security and thereby increased their productive efficiency, and it justified the prohibition of begging, stealing, and indolence by the Koran. As all superfluous wealth was regarded as productive and was, therefore, taxed, whether it was put to use or left unused, it prevented employers taking unfair advantage of labourers, for, if the latter went on strike, the idle money and property of the employers continued to be taxed. It prevented deliberate or careless hoarding, for the hoard was taxed. 'Let not those who hoard up that which God has bestowed upon them of His bounty think that it is better for them. Nay, it is worse for them,' were the words of the Koran. Hoarding for the sake of the family was likewise forbidden, for the Koran declared: 'Among your wives and your children are enemies for you, therefore beware of them. Let not your wealth nor your children distract you from the remembrance of God.' 'Establish worship and pay the Zakat,' are the constantly repeated dicta of the Koran. No rich man could be a Moslem without paying the Zakat. Finally the Prophet believed that so great would be the prosperity resulting from a greater equalization of wealth that a time would come when people offer Sadaqah and there will be none to take it'.

The second of Mohammed's measures to prevent the large accumulation of wealth in a few hands lay in the principles of inheritance. Private property could be accumulated in a man's lifetime within due restrictions, but at his death it was widely distributed amongst his offspring and kindred, and thus large individual fortunes were dispersed amongst many individuals.

The third measure was the forbiddance of usury or 'interest on money', as the dictionary defines it. So the money of Islam did not come into existence with interest attached to it, which would load the sacred duties of farming and trade with debt at the outset. Only the original sum of a money loan was to be repaid, otherwise the interest on a loan would make it destructive. In one of his most searching and prophetic sayings, Mohammed seized upon this truth: 'Although interest brings increase, yet its end tends to scarcity.'

Money was to assist trade by the method of partnership. It was not to be hoarded nor lent out at interest. It must be used for trade or spent in alms, said the Koran, 'so that the Zakat due on it do not swallow it up'. By means of partnership the ender or partner took his share of the success or failure of the enterprise. 'They say trade is just like

interest-taking, whereas God permitteth trading and forbiddeth interest.' Genuine partnerships were encouraged to further trade, manufacture and farming, but debenture-holders and commercial loans were ruled out as destructive. The imposition of the Zakat and the prohibition of interest forced money into use and into the promotion of a general prosperity which resulted from its use.

Economic ranks and occupations did not affect the general freedom of the individual. Islam destroyed money as a standard of social distinction. A man was wealthy according to the good he did to others. Money-wealth had only a limited value, whereas virtue could not be measured but by the good to mankind that followed from it.

Three taxes were attached to the products of the crust of the earth, the tithe, the *rikaz*, which assigned one-fifth of the products of mines exclusively, like the tithe, to the poor, and the *kharaj*, a levy for the general welfare of about 2-1/2 per cent on the output of the land due irrespective of whether the owner cultivated the land or not. According to Islam, land is a gift to all men, and all men are united by the bond of their terrenity in their dependence for sustenance upon the soil. Yet all could not own land. So the land was not socialized, but its products were socialized by these taxes. Through them the poor were given their measure of independence, and the general welfare was given an economic basis in the land. As the soil depended upon the use of everything that nourished it, so the soil, in its turn, was made to give nourishment to all, and to produce the social balance that belonged to it as an integral factor of the life-cycles of man.

Based on the limitation of the soil's products, the economics of Islam dictated a limitation to the acquisitiveness of individual men. As an outgrowth of this, Mohammed's instructions on leisure were also directed so that people's attention was diverted to other things than the making of individual fortunes. Through learning, service, and the call to prayer five times in the day, people's leisure was directed to self-cultivation, whereas their working hours were directed to the cultivation and distribution of material goods. This was possible, sums up Mr. Hamidullah, because Islam was a religion and not an economic organization.

With this independence that Islam gave to the individual, labour was elevated as a general duty and both commerce and farming were announced to be meritorious in the eyes of the Lord. The pursuit of the cultivation of the soil was regarded by labourers and rulers alike as a sacred duty; Mohammed himself ploughed his own land. The contemptuous sneer, which turned the Latin *paganus* or villager into *pagan*, and the man of the heath or field (Anglo-Saxon *haeth* or heath, Gothic *haithi* or field) into *heathen*, was utterly foreign to the *sanctity*, with which Mohammed and Islam endowed the duties of both.

Having freed women from their traditional subordination to the stronger sex, slaves from their ignominy, the poor from their destitution, and farming and labour from

their subordination, Mohammed turned to the liberation of men's minds from ignorance.

He made education incumbent upon every Moslem, male and female, and sought thereby to influence the minds of all men by the passionate emphasis he laid upon the value of knowledge to humanity. Ameer Ali describes this passion in these noble sayings of the Prophet: 'Acquire knowledge, because he who acquires it in the way of the Lord performs an act of piety; who speaks of it, praises God; who seeks it, adores God; who dispenses instruction in it, bestows alms; and who imparts it to its fitting objects, performs an act of devotion to God. Knowledge enables its possessor to distinguish what is forbidden from what is not; it lights the way to Heaven; it is our friend in the desert, our guide to happiness; it sustains us in misery; it is our ornament in the company of friends; it serves us as an armour against our enemies. With knowledge, the servant of God rises to the heights of goodness and to a noble position, associates with sovereigns in this world, and attains to the perfection of happiness in the next.' He would often say, 'The ink of the scholar is more holy than the blood of the martyr', and he repeatedly impressed on his disciples the necessity of seeking for knowledge 'even unto China'. 'He who leaves his home in search of knowledge walks in the path of God. He who travels in search of knowledge to him God shows the way to paradise.'

Our scholar, Ameer Ali Syed, finally gives this summary of the teaching of Mohammed in Medina: 'Islam gave to the people a code which however archaic in its simplicity, was capable of the greatest development in accordance with the progress of material civilization. It conferred on the State a flexible constitution, based on a just appreciation of human rights and human duty. It limited taxation, it made men equal in the eye of the law, it consecrated the principles of self-government. It established a control over the sovereign power by rendering the executive authority subordinate to the law -- a law based upon religious sanctions and moral obligations. "The excellence and effectiveness of each of these principles", says Urquhart, "(each capable of immortalizing its founder) gave value to the rest; and all combined, endowed the system which they formed with a force and energy exceeding those of any other political system. Within the lifetime of a man, though in the hands of a population wild, ignorant and insignificant, it spread over a greater extent than the dominions of Rome. While it retained its primitive character, it was irresistible!'"

With their personal experience of these and other Islamic precepts in action in the microcosm of Medina, the Arab leaders went forth upon their great reconstruction of many millions of oppressed men.

The Institution

Before telling the story of the institution of this reconstruction, it is, however, essential to give a brief description of the conditions of the masses, in what Ameer Ali, whose words I choose as better than my own, names the West and the East. His East does not include the great farming country of China, which, since it seems

mankind tends to be similarly affected at any one period, was also engaged in a reconstruction of the Tsing Tien system under the Tang Dynasty (A.D. 618-905) after a long period of divided States and Tartar conquests.

'In the West as in the East', writes Ameer Ali, 'the condition of the masses was so miserable as to defy description. They possessed no civil rights or political privileges. They were the monopoly of the rich and the powerful, or of the sacerdotal classes. The law was not the same for the weak and the strong, the rich and the poor, the great and the lowly. In Sassanide Persia, the priests and the landed proprietors, the Dehkans, enjoyed all the power and influence, and the wealth of the country was centred in these hands. The peasantry and the poorer classes generally were ground to the earth under a lawless despotism. In the Byzantine Empire, the clergy and great magnates, courtesans and other nameless ministrants to the vices of Caesar and proconsul, were the happy possessors of wealth, influence and power. The people grovelled in the most abject misery. In the barbaric kingdoms -- in fact, wherever feudalism had established itself -- by far the largest proportion were either serfs or slaves. Villeinage or serfdom was the ordinary status of the peasantry.'

The first thirty years of the story from A.H. 11 to A.H. 40 of the Mohammedan calendar, were occupied with the settlement of Persia, Iraq, Syria, Palestine and Egypt. Under Omar, the second Caliph, in A.H. 21, occurred the *Victory of Victories* at Nehawand, in which the Persians, who outnumbered the Arabs by six to one, were totally defeated. Egypt, too, was conquered. Owing to these victories, the precepts of Mohammed affected the fate of many millions of people. By the fire which Mohammed lighted, masses of lowly and oppressed men, as well as men of power and wealth, were warmed and enlightened to a new life.

Convinced that the stability of the Empire and its material development depended upon the prosperity of the agricultural classes, writes Ameer Ali in *A Short History of the Saracens*, Omar 'took immediate steps to settle the peasantry securely in their possessions. "They were released from the galling oppression of the large land-owners; their assessments were revised and placed on a stable basis; the broken aqueducts were restored and new ones built ... Egypt, Syria, Irak, and Southern Persia were measured field by field, and the assessment fixed on a uniform basis. The record of this magnificent cadastral survey forms a veritable "catalogue", which, beside giving the area of the lands, describes in detail the quality of the soil, the nature of the produce, the character of the holdings.' The Zakat gave independence to the poor, but the rich were not oppressed, though shorn of their excesses to promote a greater equalization of wealth. There was no communistic division of their lands nor were they taken by the Arabs. The land-holders kept their estates, subject to a fixed tax. 'Liberty of conscience was allowed to everyone, and the Moslems were ordered not to interfere with the religion of the people. Those who adhered to the old faith received the designation of *Zimmis* (the protected people or liege men). The sole inducement to proselytism, if inducement it could be called, consisted in the fact that whereas the Moslems,, who were liable to be called at any time to serve in the army, contributed

only a tithe to the State, the *Zimmis* paid a higher tax in consideration of being exempted from military service.' Nevertheless this *Jazia*, or poll-tax, was in no way onerous.

When Omar died in A.H. 23, after a reign of ten years, Othman was elected Caliph. Othman was a member of the Ommeyade family of Mecca, of the clan of the Koraish that had shown itself most active in its hatred of Mohammed. The aged Othman was elected to the Caliphate by the intrigues of the Ommeyades. They then got themselves appointed as governors of the provinces; seized the land; subverted the precepts and actions of Mohammed and the first two Caliphs of the Republic, Abu Bakr (A.H. 11-13) and Omar (A.H. 13-23), both the early converts and devoted companions of Mohammed, treated the conquered peoples as satellites and slaves, and enriched themselves by oppression. This aroused the intense hatred of the true Moslems and led to an insurrection in which Othman, at the age of eighty-two, was slain in A.H. 34.

Ali, the beloved adopted son and later son-in-law of Mohammed, was elected as the fourth and last Caliph of the Republic. No man was more revered or trusted by the Moslems than he, not only because of his intimate association with the Prophet, but because he was 'the truest-hearted and best Moslem of whom Mohammedan history has preserved the remembrance' (Major Osborn), and, because both before and during his Caliphate he so stoutly upheld the doctrines of Mohammed and, in Othman's reign, upheld and extended the practical improvements of Omar through his energy and prestige. Then, wrote the French historian Sédillot: 'One would have thought that all would have bowed before this glory so pure and grand; but it was not to be.'

The Ommeyades were the chief cause of the failure of Ali and it was through their intrigues that he was assassinated after a brief reign (A.H. 34-40). They, the Ommeyades, were supported by tribal chiefs, who had been largely weakened in authority by Mohammed's reliance on the assured and faithful Moslems of Medina.

The all-too-human hatred of these reactionaries may seem to have its justification in their deposition from free and arbitrary authority. But their fury and tenacity, of which the modern reader can scarcely form a conception, all students are agreed, had their origin in the very roots of the pre-Mohammed conditions of the Arabian people. From the very earliest times blood-feud had been bitterly active amongst the tribes and consummated in the hatred that existed between the nomadic Arabs of the desert and the farming people of the more fertile south of Arabia bordered by the Arabian Gulf and known as Yemen. 'This blood-feud', wrote the Dutchman, Reinhart Dozy, in his *Histoire des Mussulmans d'Espagne*, translated into English by Mr. F. G. Stokes, 1913, 'has endured for twenty-five centuries; it can be traced back to the earliest historical times, and is far from extinct to-day.'

To the question why it preserved its bitterness with such extraordinary tenacity for so many centuries, Dozy wrote: 'Handed down from generation to generation in spite of

community of language, laws, customs, modes of thought, religion, and, to some extent, of, origin -- since both races were Semitic -- we can only say that its causes are inexplicable, but that it is "in the blood".' Nevertheless, it may be, as we have seen in Chapter 6, that the hostility lay in the ultimate relation of the two peoples to the soil, farming and trade on the one hand and nomadism on the other, and in the tenacity that characterizes the Semitic peoples. Whatever the true explanation is, this passion for feud and tribal independence runs, as a rebellious and anarchical spirit, through the pages of Arab history. It brought about the failure of Ali's courageous attempt in Othman's and in his own short reign to uphold and re-establish the precepts of Mohammed; it led to his assassination by Ommeyade intrigue; it brought the Ommeyades to the headship of the Moslem world, the cruel persecution of the family of Mohammed and the sack of the sacred city of Medina; it foiled the Period of Conquest of the Ommeyades and brought about the defeat of the Moslems by the Christians at Tours on the bank of the River Loire; it took its part in the disintegration of the Kingdom of Spain; it promoted the disintegration of the Saracenic Empire of the Abbasides and caused it to fall to pieces before the assault of the nomadic Mongols. 'It led', says Ameer Ali, 'not only to the end of the Republic, but also to the downfall of the Saracenic Empire.' To-day, it seems to the Europeans, that the Arabs are prevalently nomadic.

The Ommeyade Dynasty, which followed the assassination of Ali, with its capital at Damascus, endured for ninety years. Only one Caliph of the dynasty, Omar II, strove to re-enact the precepts of Mohammed. He, like Ali, was assassinated. The Ommeyades were themselves destroyed by the Abbasides, the descendants of Abbas, the uncle of the Prophet. One, Abd-al-Rahman, escaped to Spain and there founded the great Spanish Dynasty of the Ommeyades.

The Achievement

The Abbasides ruled from A.D. 750 to A.D. 1258, when their capital, Baghdad, was seized by the nomadic Mongols under Hulagn, the Caliph, and 800,000 inhabitants butchered within a week, and the great system of irrigation destroyed.

It was under the Abbasides that the great task of reconstruction was accomplished. Mansur, their second Caliph, was the first of a series of brilliant Caliphs, equal to that of the contemporaneous dynasty of the Ommeyades of Spain. The story of the development of the civilization of the Moors has many resemblances to that of the Abbasides, for both carried out the statesmanship of the fixed Islamic laws.

The Abbasides brought the era of conquests to an end. They renounced further warlike enterprises, and devoted themselves to the development of the land, the prosperity of the peasants, the promotion of commerce, the construction of roads and caravanserai, the establishment of charitable institutions, the spread of education, and the stimulation of literature and the arts.

The system of irrigation, which the Abbasides extended and amplified, was one of the

most wonderful in the world. Only time-honoured China and Islamic Spain had anything to compare with it; in actual fact, the Abbaside irrigation was superior to that of the Chinese, for it had control of the whole of the two great rivers, the Tigris and Euphrates, whereas the Chinese had no control over the sources of their great rivers.

The spirit and practice of the great riverine civilization of Babylon were revived. Throughout the whole Abbaside Empire the work of promoting agriculture was regarded as a religious duty, and the art of cultivation was developed and maintained with religious zeal. Mansur first abolished the payment of the Ommeyade money-tax upon grains and replaced it by a payment in kind. He extended this principle to other crops, and, in the case of the most fertile of lands, the produce-rates were fixed at two-fifths of the whole. Remission of taxes were frequent at times of stress even in the reigns of his most severe successors. By thus following the true economics of the soil, the prosperity of the peasants was at once implanted and the soil itself conserved as the basis of the State.

The method of land taxation was, however, not uniform throughout the Empire. 'In Babylonia, Chaldea, Irak, Mesopotamia and Persia there were numerous landowners and peasant free holders', writes Ameer Ali in his *History*, 'whose rents were permanently fixed upon the basis of agreements entered into at the time of the Conquest. No variation could be made in the tax leviable from them, and they were thus protected from all harassment. The same boon was enjoyed by the village communities of Northern Persia and Khorasan.' In a brief time, under this just care, the countryside of Irak and Southern Persia had the appearance of a veritable garden. Between Baghdad and Kufa especially, it made a setting of verdure for a number of prosperous towns, flourishing villages and fine villas. There was a teeming population. According to the writer of the article 'Irak-Arabi', in the 11th Edition of the *Encyclopaedia Britannica*, quoted by Mohammed Fadhel Jamali, Director of Education, Ministry of Education, Baghdad, in his book, *The New Iraq*, 1934, it was perhaps five hundred times as great as what 'it usually contains', in its present decadence.

A further feature of the greatest value to farming, with its *essential character of locality*, was the principle of self-government, that freedom for local customs and traditions on which Mohammed laid such stress. The Abbasides spread this precept throughout their dominions. 'The government carried its policy of non-interference with the separate communities sometimes to the extremest verge, to the detriment of its own interests. Each village, each town administered its own affairs, and the government only interfered when disturbances arose, or the taxes were not paid.' But so vital was the land, and so stupendous the system of irrigation which nourished it, that the construction of new canals and the cleansing and repair of old ones were entirely in governmental hands, as also was the maintenance of an efficient river police. The cost of the new canals was borne by the State, that of cleansing and repair was shared by the State and the recipients of the water. The workers on the land

opened up by the new canals, consequently started their work without the shackles of a debt that had to be paid off. The benefit to the new farmers was primary, and, from their produce, they paid the usual taxes for the maintenance of the State, which itself repaid them with so many benefits. In this way the soil was dominant and money the adjuvant.

With the same magnanimity as they bestowed on the soil, the Abbasides developed the precepts of Mohammed on knowledge. Academies, colleges and schools were everywhere established; education was opened to all, urban and rural; the education of the women proceeded on parallel lines with that of the men. This zeal for knowledge was developed to the highest pitch, as Ameer Ali, in *The Spirit of Islam*, writes: 'Under the Abbasides we find them (the Moslems) the repositories of the knowledge of the world. Every part of the globe is ransacked by the agents of the Caliphs for the hoarded wealth of antiquity; these were brought to the capital, and laid before an admiring and appreciating public. Schools and academies spring up in every direction; public libraries are established in every city for every comer; the great philosophers of the world are studied side by side with the Koran. Galen, Dioscorides, Themistius, Aristotle, Plato, Euclid, Ptolemy and Apollonius receive their due meed of appreciation. The sovereigns assist at literary meetings and philosophical disquisitions. For the first time in the history of humanity a religious and autocratic government is observed to ally itself with philosophy, preparing and participating in its triumphs.' What this zeal for knowledge meant for farming, we have already seen in Chapter 21.

This great reconstruction was to be witnessed in every country, where Islamic culture was implanted. It was the same story in Persia, Syria, Iraq, Egypt, Mauritania, Sicily and Spain. It seemed as if there was something magical, something beyond all previous conceptions of man, in the arrival of Islam. Spain, Mauritania, Sicily and other countries, previously stagnant or in decay, blossomed into active life. Idris of Medina, for example, escaped from a false charge of drunkenness. He won the adhesion of the Berbers of Mauritania and founded the Idriside dynasty. He built Fez and made it his capital. Under the new spirit Fez became a famous seat of learning, and the country, of which it was the capital, leapt into wealth and prosperity. Musa, Abd-al-Rahman and their successors in Spain, Majorca, Minorca, Sardinia, Corsica and a part of Sicily, in a very short time established a new culture and prosperity. There is nothing exactly like this in all history. The early Roman Empire and the Scientific Era are no parallels, because they both progressed, as we have seen, at the expense of humble peasantries and the exploitation of the soil. On the other hand, growth in prosperity in these Islamic countries *occurred in all branches of social life*. Farming, manufacture, trade, art, education, knowledge, all attained a very high level. *They increased in power and capacity equally*; they attained a balance amongst themselves, because they based themselves on a highly developed and conserved life-cycle, of which the Spirit of Islam was the creator.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 23

Recapitulation

In a chapter on Recapitulation designed to sum up the principles of reconstruction by way of the soil, I could have taken other civilizations than those of the period of Islamic success as a measure of our present needs. Mr. 0. F. Cook of the U.S. Agricultural Department, for example, tempts me with words I have already quoted and will here repeat: 'Agriculture is not a lost art, but must be reckoned as one of those which reached a remarkable development in the remote past and afterwards declined.' This is his conclusion after his examination of the farming system of Ancient Peru.

William Prescott, in his *History of the Conquest of Peru*, 1847, gave a brief account of that remote farming. The land, he wrote, was divided into three parts, one for the support of the national religion and the sick and infirm, one for the maintenance of the Royal Family and Government, and one 'divided, per capita, in equal shares for the people'. By law each man had to marry at a certain age, and the land was re-allotted each year and 'increased or diminished according to the number of the members of his family'. None were allowed to be idle 'from the child of five years old to the aged matron not too infirm to hold a distaff'. Prescott then discussed this agrarian law, and, of European countries that resembled it, he selected that in Judaea as 'the nearest approach to the Peruvian constitution'.

Nevertheless, our information, or mine at least, of this system of irrigated fields 'cultivated wholly by the people', is so scanty and remote that thorough and practical to the highest degree as it was, it would have been quixotic for me to have made it a measure of choice.

The same applies to the riverine civilizations of Iraq; knowledge of essential details is lacking. These civilizations collectively offer a stability of the soil of some four thousand years, but so far off is this period that again it would be quixotic to choose

ancient Iraq for modern guidance.

It is a very different matter with a far more numerous people of a like duration of four thousand years, the Chinese, a people whose farming, right up to the years preceding the Great War of 1914-18, earned the unstinted praise of that genius of agriculture, Professor King. The introductory chapter of his *Farmers of Forty Centuries* is a well-deserved paean to the Chinese farming, carried out in spite of the floods of their great rivers, which, rising in the vast area of Tibet, have been beyond their control. Moreover, they have in their history records of several reconstructions by way of the soil one of which, that of the Tangs, was contemporary with the Islamic reconstruction. When their society was disintegrated by the incursions and conquests of the Tartars and when their land was devastated, the first task of a Chinese dynasty after overcoming the Nomads was the reconstruction of their peasant-farming system.

In the West, there has been abundant studentship given to the arts of China, and especially to its pictures and ceramics, but it has ignored the greater art, the art of agriculture and its reconstruction. One student, however, of the Columbia University, New York, Dr. Ping-Hua Lee, has been a fortunate exception, and this gifted author has given accounts of the Han and other dynastic reconstructions of the system of land tenure of the Chinese sages, of which I made use in the third chapter of my *Restoration of the Peasantries*, under the heading of 'The First Agricultural Path'. The history and character of these reconstructions, and of Chinese historic farming generally, to my mind and to that of the late Professor King, offer a wide field of invaluable research to future western students, but that time has not yet come. When it does come it will, doubtless, reveal a number of principles of reconstruction by way of the soil at present not available.

For these reasons, therefore, I have chosen the Arabic reconstruction, and for the further reason that they were, according to many scholars, the initiators of the modern sciences. It is true that we have surpassed their sciences to an immeasurable degree, but the same cannot be said of their arts, and particularly of their farming as a national art. Here we have by no means surpassed them; on the contrary, we are far below their level. So, although by their violent jealousies and extravagances, such as the Chinese were never guilty of, the Arabs exposed themselves to their enemies, who destroyed their empire, and though, with a fatality that seems as inexorable as it is inexplicable, they have almost reverted to their original desert status and to-day nowhere exhibit any art of agriculture for our enlightenment, I have chosen their historical reconstruction as the measure of what should be possible to us in our present urgent need. Consequently, to give coherence to my subject before my final chapter, I propose in this reconstruction to review the first twenty chapters of my book in the light of chapters 21 and 22.

Chapter 1 discloses the general theme and purport of the book as a need to accept the priority of the soil in a sane and sound civilization. It describes the intimacy and oneness of Man with the soil, which forms the initial factor of life-cycles, in which

men have their being. It reveals the wholeness or health, which arises from a complete adherence to the life-cycle by a brief account of possibly the healthiest people on the earth. It goes on to show how the human family conjoined with property in the soil, through which the life of the soil and of humanity become vitally interwoven. It ends with an account of the most enduring association of soil and family in history, that of the Tsing-Tien System of the Chinese.

The duration of the Chinese family system and the degree of positive health of the Hunza both surpass what the Arabs attained. Nevertheless, Islam attached great significance to both family and health. Mohammed asseverated the sanctity of agricultural work and coupled with it the declaration that the land or other property, was inviolable as long as it was rightly used. Islam, founded upon the Prophet's dicta, embodied them in its fixed laws upon the freedom and security of the peasantry and the inviolability of property rightly used.

As regards health, we know that, at the time of the rise of Islam and after, Europe was frequently devastated by epidemics. The condition of the towns and the homes of the people was one of extreme filth, and this condition has lasted amongst the poor urban classes almost to the present day. In many of the most populous capitals of Europe not a single public bath was to be found, and religion itself made personal dirtiness almost synonymous with holiness. The practice of Islam was the very opposite of this. Mohammed himself taught the paramount importance of hygiene. He also placed right feeding as the first source of health and decreed that lack of restraint in food and drink was 'the source of all physical ills'. Islamic civilization was marked by its insistence on bodily cleanliness, and public baths were provided on a liberal scale. Drainage in towns was efficient without being wasteful. Nevertheless, though vastly superior to anything in Europe, Islam needed the assistance of the medical art, which it developed to a high degree as shown by the fame of its Schools of Medicine and its hospitals, and the knowledge of botany, pharmacy, chemistry and other branches of medicine, from which much of the modern healing art is derived.

The next four chapters, Chapters 2 to 5, tell the story of Rome and the evil effect of its capitalistic civilization upon the peasantries and family, upon the food of the poor, and upon the soil resulting in its extensive loss through erosion and the formation of marshes. Islam supported the peasantries, honoured the family, dictated that even the slaves should have the same food as their masters, and took every care to conserve the soil.

Chapter 6 is concerned with Nomads and Farmers, and the effect which scarcity of the food of the Nomads had upon the civilizations of the Farmers and the history resulting therefrom.

Chapter 7 brings forward two contrasting examples, the first of the deprivation of the soil of the Falkland Islands under the dominance of modern commerce, and the second of the renovation of the soil of a Baltic dairy farm by correct farming and ecology. Both form examples on a small scale of vital issues. The local

self-government in things of the soil would have avoided the first; the second is in accord with the final unity of all living things of Mohammed's teaching.

Chapter 8 gives an account of the proper and the wrongful uses of urban and rural wastes. Islamic agriculture was, amongst other things, based on the proper use of wastes. Chapter 9 continues this theme and shows the reason why the cash-nexus leads to the wrongful use of wastes. Under the guidance of Oswald Spengler, it develops the difference in thought and values of the countrymen and townsmen, which are illustrated by the different character of their taxations, the natural character of that of the farmers being payment in kind or farm products, that of urbans payment in money. This difference was recognized and acted upon by Islamic civilization. The chapter continues with further illustrations of the economics of the soil, including an account of the Chinese economics of the use of water for the soil, as given by Professor King. It concludes with a brief description of the disastrous effect of the dominant money values upon the fertility and health of the soil.

Chapter 10 contains the story of the peasantry of England and the robbing of the food of the soil by the lords of the manor, culminating in the ruin of the peasantry in the Industrial Era by acquisitive men. Only the peasants of the Isle of Axholme escaped this fate.

The story shows especially the entire lack of decent conduct towards rural labour at the introduction of modern capitalism and is the precise opposite of the sacredness that was bestowed on all labour by the introduction of Islamic civilization.

Chapter 11 is the first tale of primitive agriculturists, those of Kenya, under the aegis of commercial farming, so poignantly told by Mrs. Huxley. It is a story without redemption, but not without the retribution of an extraordinarily rapid and devastating spread of erosion of the soil. Chapter 12 is a second story of a primitive people in Nyasa lured or forced from their land to serve in the adjacent gold and diamond mines. It has an all-too-near resemblance to the fate of the English peasantry as told in Chapter 10. The conditions of the miners in the gold and diamond mines was never as terrible as those of English miners under which children of six years, harnessed to small carts by chains, drew coal along the passages of the mines, but it was one with a large share of bondage, drunkenness and disease, under the stress of which many great and successful social and medical improvements have now been effected.

Chapter 13 tells the story of the salvation of Tanganyika, effected by the little tsetse fly, from the rapid erosion that has visited Kenya. It also contains a most promising story of redemption in the proper use of rivers, in which, instead of forming boundaries of human hostility with the ill-effect that such a river as the Rhine in particular has had, they are made beneficial by being used primarily for people on either bank.

The last tale of the due effect of dominance of money over a primitive peasantry is that of our oldest colonies, the West Indies, in Chapter 17. The hardships and erosion

it has caused is made the more graphic by an account of an uninterfered with, and flourishing island -- that of Lombock in the East Indies.

Under the Islamic principles of the treatment of peasants, none of the disasters of Chapters 11, 12 and 17 could have been brought about; on the contrary, the Lombocks would have been multiplied, as the results in the Mediterranean Moslem islands show.

Chapter 14 is a philosophic interlude on the extraordinarily delicate and infinitely varied nature of our food substances built up from only a few elements, the most common of which are not only earthly but also aerial, and the need for a wider conception of them and their nature, if positive mental and physical health are to be attained.

Chapter 15 is another tale of the effect of the dominance of money. It concerns itself with Sind and Egypt, and shows the danger to the alluvial soil, of trying to force it out of its primal character in order to make two blades grow where one or none grew before. The perennial irrigation, which has been introduced into Egypt and Sind, has been first financed by money at interest, and thereby has followed another path than that of Islam, in which the cost of new canals was borne by the government and that of cleansing and repair alone shared between the State and the recipients of water. There was no interest; there were no bankers who brought the huge sums into existence out of nothing and issued them as loans to be repaid with interest. The first thing the bankers sow upon the new land is debt, as one might sow tares amidst the wheat. They enforce greater productive effort upon the land than it will bear. 'Although interest brings increase', said Mohammed, 'yet its end tends to scarcity.' This great saying again proves itself true in this modern example. Both in Egypt and Sind, the forcing of the land out of its natural capacity to make it 'pay', has already produced scarcity, through alkalinity. Writing only from the purely agricultural side, Professor King says that in all probability the people whom our modern civilization has supplanted knew of this error and had tried and abandoned perennial irrigation. Islam went further in the interests of soil. *From the very start it shut out the men of greed*.

Chapter 16 is a second interlude chapter. It is a review of what are known as artificial manures. The introduction of artificial manures was a fragmentation, an incursion of one particular section of scientists into the realm of farming. These scientists took a partial view of the character of the soil. They took a few of the most important chemical elements of the soil, and tried to make them into a whole. They sought to displace natural manure with measured doses of these chemicals; they first diagnosed the land, and then prescribed for it. They began to be important when the quantity of natural manure itself began to decrease owing to railways taking away horse traffic and sanitation abolishing the disposal of refuse upon the soil. With motors displacing horses, and tractors displacing horses and oxen on the farm itself, artificials became yet more strongly advocated. They have their occasional place in increasing the

amount of produce of underfed land, and they have been of great service during the period of war. But they have distracted thought from natural manures; they have helped to hide away the disastrous misuse of wastes. They are a fragmentation, a default in philosophic thought upon the wholeness of the association of the dead and the living in farming. They have, therefore, been accompanied by a farming so beset by disease that the scientific farm has become a blend of factory and hospital, producing products inferior in health, quality and taste, and deterioration of the soil.

Artificials, of course, played no part in the farming of the Islamic civilization; nor, indeed, of that of ancient Peru, nor of any of the great farmings that men erected in the past.

Chapter 18 is the tale of the German Colonies, in which the creed of the rights of the fittest received almost its final consummation. The latter part of the chapter tells the happy stories of these same colonies under the guardianship of the Permanent Mandates Commission of the League of Nations. Differing in manner, the three governments, those of the Union of South Africa, of France and of Britain, effected a miraculous change by means of principles approaching, and in the case of Tanganyika nearly identical with, those of Islam, when dealing with oppressed peoples of the soil.

In Chapters 19 and 20, the huge countries of Russia, South Africa, Australia and the United States illustrate the climax of the destruction and death of the soil which our modern values make inevitable. In spite of their great scientists, all these countries have been placed in grave danger owing to erosion.

In Russia erosion, particularly that due to deforestation, is of longer duration than in the other three countries of later development. But, with Russia's modernization and especially its almost fanatical faith in the tractor or machine farming, Professor Kornev has had to utter the warning: 'At the present day there are huge areas in the U.S.S.R. where, owing to the excessive breaking up of topography, whole territories formerly under profitable agriculture are now occupied by immense ravines and infertile wastes.'

South Africa has been described by Mr. R. 0. Whyte under the italicized sub-heading of *The Transformation of South Africa into Semi-desert in the Twentieth Century*. Mr. E. S. Clayton, in *Overseas Investigation*, 1937, declares: 'There is no doubt that we Australians are in a process of transforming the semi-arid areas into desert at a more rapid rate than in the U.S.A.'; and.in the wetter, riverine districts many parts are gravely affected by erosion.

Finally we arrive at that great country, which has become the leading modern country in the production of food for itself and other countries, as well as of other essential crops for the benefit of all men and its own prosperity. Yet in doing so, it is fulfilling the prophecy of its own Professor Shaler that unless some radical change is adopted, we must anticipate a time 'when our kind, having wasted its great inheritance, will

fade from the earth because of the ruin it has accomplished'. The chapter closes with an example of a great awakening, a powerful effort towards redemption in the U.S.A., the Tennessee Valley Authority, which follows the values of Islam in the priority given to local, agricultural knowledge, and the balance and mutuality of all labour, whether it be in the factory or on the land.

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Reconstruction by Way of the Soil

by G.T. Wrench

Chapter 24

Action

It may seem boastful on the part of a writer to say that his subject is world-wide, but the world, at one time so very large, has shrunk a good deal in these latter days and a number of questions, once national or local, have consequently become world-wide. Certainly, if any question has a world-wide significance it is that of the treatment of the world's crust. Action, therefore, at this present time, in the reconstruction via the soil must have a certain world-wide character attached to it.

What, then, of a world-wide character can form a means of action in reconstructions via the soil? The present has shown convincingly what, indeed, scarcely needed another demonstration, namely, that at a time of war every nation engaged, whatever its form of society and government, is not hindered by money. Nor is it hindered by unemployment. At such times there is work for one, and all, and work takes precedence of money; money does not call forth work, but work money. The impulse to action is so great that it takes complete mastery of men and matter. Hence, for a reconstruction of the soil, a very wide impulse will have to be called into being. It is not to be expected, of course, that the impulse will have the cohesive fury of a people called to war, but it should certainly seek for means that are world-wide in their character.

What means of this wide character are, then, favourable to a big-scale movement?

First and foremost there is the unique positive achievement of the war. The war has achieved, as never before, *the technical unity of the world*. The spirit of unity is quite a different matter. The riven spirit of the pre-war times remains, and as yet there has been nothing in the plans for the post-war period to prove positively that it has been radically diminished. This is as one might expect. The characteristic of the last few decades has been the improvement of technique, to which one great war, one great revolution, expectation of war, and a second great war have jointly given an impulse

that has been terrific. This technical achievement cannot possibly be overlooked as means to reconstruction. With its wireless reaching so many homes and papers, its multiple air routes and air bases, its great roads, even amidst the supposedly eternal defiance of the mountains of Central Asia, its innumerable mass-made ships, its thousand inventions in means of communication, it has developed a capacity to weld the world together, such as itself foretells a new era. The world has been technically transformed into one borderless whole, for neither the air nor the ether has frontiers. Unless, then, mankind is to be overtaken by physical degeneration, unless a decay of character brings with it one of those periods of disintegration of civilization, with which historians are familiar and of which the decline and fall of the Roman Empire has been the classic example in the West, there is no possibility of the future technical disseverance of the world. Its technical unity is a fact; all depends upon the uses to which it is put. It may, for example, be made subservient to a revived pre-war money power through a continuance of the officialism necessitated by the war. It may be limited by a variety of fragmentations, if the divided nationalities continue to indulge their political appetites and make the primary needs of their peoples means to national aggrandisement. Its use and misuse may, indeed, lead to further wars, famines and increasing social chaos. All this will be possible, if men continue to ignore the crust of the earth, until the uncontrollable increase of the soil's devastation sinks men into despair or forces them, before it is too late, to use this tremendous technical power for what its wide-world capacity seems to be designed, namely, the world's terrene salvation and not its destruction.

Those, then, who are convinced of the need of reconstruction via the soil, should not now allow themselves any laments for the past or indulge in vain dreams of a world other than it is at this very present. They should look upon the technical unity of the world as a giant of assistance to the awakening of the brotherhood of man through the common parent of all, the soil. They have a message and a means of communication commensurate with its vastness. Their message has undoubted prior claims because, physically, mentally and morally, it affects all men who tread the earth. If they can enforce themselves upon the world's wireless; if, by travel, they can reach once distant lands by air-speed, which now makes east and west and north and south neighbours; if in the world's press they can publish to innumerable readers at one and the same time the more striking news of their movement; if men of each country can communicate to men of other countries what they are doing, what developments have been accomplished or are expected, then they will fill the world with the creed of the soil. There is much to communicate at this day, as soon as the din of war has become silent. This will be far more when the thoughts of men are no longer directed to the slaughter of life, but to the means of its conservation.

Each country will need its band of men and women to take a part in this new unity of the world. The type of men required to form the initial bonds is of the greatest significance. It is at once clear that they must be of a kind that was almost voiceless in the period, between the two great wars, when their contraries, by converting soil-fertility freely into money, were 'drawing the whole world headlong to starvation', in the words of Mr. Jacks. Upon their ignorant greed, there was, says Mr.

Jacks, at that time only one check, the threat of war. Then came the actuality of war, and the governments of the Great Powers engaged in it, realizing at last the paramount and primary character of soil-fertility, allowed it no longer to be turned freely into money, but treated it as a national armament no less precious than were the metals and the chemicals. This dominance of soil over money must not be allowed to relapse with the cessation of the war. *The lesson then learnt must this time be unforgettable*.

A new social, non-military war, indeed, opens out, the war on behalf of the soil and of the healthy life and physical freedom of men. In this war, the soil will have, in the beginning, many opponents. Firstly, except for men of genius and the capacity it gives them to change an outlook and break with the personal trammels of the past, those men who rose to high authority before the war may be expected to be opponents, *from the very fact that they rose to authority under the ruinous values of the earth's devastation*. These values will still be treasured, because the use of them brought them their public power. To purge themselves of the gross defect of mind that the values entailed, will be beyond their capacity; whether they wish it or not, the familiar spirits will not cease to haunt their thoughts and actions.

Then, there are aliens and men without any country of their own, without, in the first case, any inborn, native love for the land in which they have their refuge; in the second, without any actual kinship of mind, occupation, and tradition with the soil. With both money is, of necessity, the paramount object, because the only world-wide rival to money is the soil. Such men are dangerous.

Urban people are likely to be opponents at the beginning, for urbans become perforce not individuals so much as mass. In small matters they hold the opinions of their set; in larger they are subject to mass-emotion. Their interests and faiths wax and wane, are hot and cold. Fed by selected news and spurred by propaganda, they are the objects of unfixed laws, each of which, like a wave on a sandy shore, wipes out the impress of its predecessor. Severed as they are by modern town life from the soil and its creative powers, they are alien to fixed laws, by which alone its dominance can be maintained.

Modern education itself is an opponent and a powerful detractor of the land, because the soil is only regarded in it as something that can be ignored. All education for the young, one can say, in all advanced countries seems to have this profound defect. Personally I am best acquainted with my own education, that of a public school in England. The school was situated amongst cultivated fields and riverside pastures. Yet never once was the local character of the land of sufficient significance to be mentioned by the teachers. I realized vaguely even then that our education *did not start at the beginning*, not from the soil and the river from which our life began, *but from somewhere else*, as if the roots of being did not matter in education and could be left invisible or unknown almost for ever to the instructed mind. It taught us to be gentlemen, something superior to the soil. It cut us away at the start from the Islamic

sanctity of the soil. And this stigma most of us had to carry throughout our lives, only the rare sceptic might escape from its trammels. Even when the Empire's needs called some of my colleagues to the charge of primitive agricultural peoples, the stigma remained. 'Unfortunately most of the Europeans who come out to this country (Nigeria)', stated Mr. G. N. Herrington, at a West African Agricultural Conference in 1938, 'have received an education which is divorced from rural life and few have any knowledge of its interest and variety, or the intelligent skill that rural life entails. This type of education has created a traditional attitude that is very difficult to overcome.' It has only very rarely been overcome, only in great sceptics and men with rare sympathy for their rural subjects, such as were pre-eminent in British India before the Mutiny, the four M's, Sir Thomas Munro, Sir John Malcolm, Sir Mountstuart Elphinstone and Sir Charles Metcalfe. Because of this almost invincible, traditional attitude, our empire over rural lands has been one mostly divorced from rural life and antagonistic to the soil.

In addition, to the famous British public schools, education in our state schools, in the United States and other countries, has had the same tendency. In the German University, where I spent eighteen months in post-graduate education, it seemed to me, then more awakened to the fault, to be the same; men with so-called brains were considered to be suited for something better and more *lucrative* than for work upon the land. This profound fault in the education of the Industrial Era has worked untold mischief in health, sanity, food and the conservation of the soil. It makes education undoubtedly an opponent, not an adjuvant to reconstruction via the soil.

The new men and women -- for the war has brought many women in direct contact with the land -- will be those who have been shaped and fashioned by the soil to a serenity, a sense of the spaciousness of time, and a capacity of individual judgment. The soil itself has been their textbook and printed books only subsidiary. Books widen the understanding and give to their students knowledge of many chemical and physical properties of the earth's crust, but they have not the magic in revelation of the soil itself. They are very valuable supports and helpers, but they are not initiators of the sense of kinship. Initiation belongs only to the parent of life.

The new men and women know the soil and its creative powers personally, learning chiefly through their eyes and muscle-sense, and not through their ears. Their knowledge and feeling for the soil are the same as they are for other living things, a matter of touch, smell and sight, a physical response to contact with it. It is made up of a variety of factors; the feel and sight of rain, snow, dew, sun and wind; the characters and purposes of hedges, woods, fields, hills, valleys and plains, of insects, plants, flowers, weeds, all subject to the seasons in their progress through the years. It is, then, something very real, something very vital, something that proclaims an ordered multitude of being, far transcending the ephemeral life of individuals. 'It is to the fresh air of the open field that we belong by right,' said Goethe. 'It is as if the Spirit of God there breathes immediately upon men and thereby a godlike strength exercises its influence.'

The new men and women possess or gain a health that transcends what the practitioners of scientific medicine have taught the public to regard as health, namely, something that can be acquired by a process of severally discovering and putting into practice means of escape or recovery from diseases in their severalty. What will be required is not this, but the positive, whole health, which exists in itself quite apart from disease. It will be required, because it is a necessary prerequisite of the comprehensive simplification which the times require. Cleverness there is at the present day in abundance, for when the simplification of positive health is mostly absent, cleverness finds opportunity in a thousand hydra-headed problems. It is for this reason that, in spite of the numbers of educated, clever men and women and in spite of their signal ability in dealing with fragmentary social and political difficulties, in their lack of the central understanding of what was really happening in the world they failed entirely to avoid the emergence of a series of catastrophes. Health, therefore, there must be. Its simplification -- such as healthy fields bring healthy men -- of hydra-headed difficulties is essential.

Health is, as Goethe said of truth, like a diamond, it emits its rays in all directions. Being whole itself, it brings with it a lively valuation of the things of health and wholesomeness, and a ready acceptance of them with rejection of the fragmentary. Its convictions are not mere matters of mental persuasion. They are matters of bodily response, sober in action and hard to oust, for they are creatively positive. By right choosing, they prevent the complication of many particulate solutions burdening a problem with much argument, for they are attracted to the right intuitively. The correct terrene life is in reality not nearly so difficult as the wrong, because it is *simple* in the root meaning of the word, which is unity.

It is to men and women so equipped that the initial guidance of reconstruction should be entrusted. Power comes later, when conviction of the need has become widespread. Then power will be given, as it was willingly and freely given by the people to its leaders during the war. Of this power, the great urgency of war has provided many valuable precedents, the memory of which, it is hoped, will not be permitted to die out with the rapidity that affects the day to day memory, which the swift transition of events and the concentration on those of the present inculcate in the public. Of these precedents there are few which surpass that established by Lord Woolton, Minister of Food in Britain. His is, to my mind, a classic example of an inspiration to workers in many, if not all, countries concerned in these primary matters. One only wishes that reconstruction via the soil could be almost a continuance of the work done by the Departments of Food and Agriculture, without the long lapse that seems inevitable for the initiation of the public to the need for reconstruction.

As to the nature of the work of initiation, it will come under some such headings as the following:

1. The restoration of the peasantries and peasant families as the cardinal

cultivators of the soil; the use of large estates, where suitable to particular soils, forms of cultivation, or social conditions.

2. The freedom of the soil from money-power.
3. The first claim of the soil upon a country's water; the local control of its distribution.
4. A rural education, which is, locally and generally, a true soil-education.
5. An education of all urban populations, which begins at the beginning in the soil and in the life which it provides to all men.
6. The adoption by both town and country of the rule of return.
7. The unity of the healths of the soil, the plant, the animal and man.
8. The right of all men to their share of essential foods and work.
9. The use of modern technique in promoting and maintaining the brotherhood of man throughout the world by the common bond of the soil and its conservation.

The gateways of change have been thrown open by the war, and when I venture near them to descry a vista of the future, I must confess that I am possessed by a dazzling vision of which this cruel war seems to be the immediate, creative cause.

The war has brought together, as allies, the four Powers that have control over the four greatest areas of land upon the surface of the globe. These four Powers divide themselves by neighbourhood into two pairs, namely, China and Russia, with a basic similarity soon to be propounded, the other pair, connected by the mediate country of Canada, the United States and the British Empire, the two leading capitalistic powers of the world.

These four allies form a strange conjunction of many differences. There is first the aged China, with an unequalled history of stability and conservatism, now torn asunder by the inroads of modernity. Secondly, there is Russia, also an ancient, historical autocracy, which has recently overthrown capitalism and with so fierce an energy has created a Collective State. Thirdly, there is the United States, so compact in the spacious unity of their land, in which they endeavoured to shut themselves from the troubles of the world, but suddenly aroused to the futility of this isolation by the catastrophe of Pearl Harbour. Lastly, there is the British Empire of dominions so wide and varied as to make it the leading power of the world, but aghast at the discovery of its inability to protect its far-flung possessions and almost its homeland, in the early years of the war.

There are, then, apparent infusible differences of need and necessity in the character and circumstance of the four allies, and especially do they reveal themselves if attempts to effect a fusion are made by the agency of politics and politicians.

One general need, however, indissolubly binds the four. It is to prevent the repetition of the present in the future by precluding the possibility, now and for ever, of further irruptions of the Teutonic Northerners or their pupils of the Pacific Sea.

Apart from this need it must seem, to those not instructed in the present terrene state of mankind, that genuine unity will find no bond in the manifest differences of character and circumstance of the four allies. Yet there is such a bond, the bond that ultimately unites all terrene men in an ultimate similarity, and that bond is the soil. *It is the soil, and the soil alone, which can bind the four Powers together in a reconstruction of life. All four Powers, and with them the rest of the wide earth, are bound together as to their future state by the perilous condition of the world's soil. None can escape its dangers in the new technical unity of the world. That is the one imperative and vital bond in their conjunction for reconstruction.*

Let us take the four allies severally and see what contributions they can make to this fundamental question of life itself and to their own particular needs with regard to it.

The Chinese are by far the oldest people of the allies. Their contribution is that of the accumulated wisdom of four thousand years.

None have better described this gift of the historic Chinese and their pupils the Koreans and pre-modern Japanese, than Professor King in a partially written *Message of China and Japan to the World*, which he proposed to add to his great book on the *Farmers of Forty Centuries*, but which purpose was frustrated by his death.

In the part of this message that has survived his death, he wrote: 'It could not be other than a matter of the highest industrial, educational and social importance to any nation, if it could be furnished with a full and accurate account of all those conditions which have made it possible for such dense populations to be maintained upon the products of the Chinese, Korean and Japanese soils. Many of the steps, phases and practices through which this evolution has passed are irrecoverably buried in the past, but such remarkable maintenance attained centuries ago and projected into the present with little apparent decadence merits the most profound study. Living as we do in the morning of a century of transition from isolated to cosmopolitan national life, when profound readjustments, industrial, educative and social, must result, such an investigation cannot be made too soon.'

The practices and the methods, by which these meticulously careful farmers conserved the fertility of their soils are nowhere better described than in the pages of King's book. But he makes no specific mention of the Tsing Tien System of which Dr. Ping-Hua Lee, in Volume 99 of the Columbia University of New York's *Studies in History*, wrote: 'The whole history of the government administration of agriculture in China coincides with the Tsing Tien System. Its vicissitudes, its crises and its epochs were timed by the abolition or re-establishment of the System ... It is fortunate for the economic historian that the Tsing Tien System is coincident with China's political history.'

Yet, not the Chinese farmers' devotion to the rule of return; not their incomparable

and tireless spreading of the mud of their numerous canals to the extent of seventy tons per acre; not their careful preservation of the humble earth-worm, who, said Darwin, spreads ten tons per acre of an even finer soil than silt upon the fields he studied, in addition to the other services he so eloquently eulogizes; not the irrigation of their carefully levelled fields; not the mixed crops, will form a bond more firmly riveting peasants to peasants than this Tsing Tien System. What else, indeed, is the *Kolkhoz* System of the present Russians than the Tsing Tien System modified to suit their imperative duty to provide food and other soil-products for the hundred and more new manufacturing towns which were built to give them their place amongst the modern Powers, and to equip them for the Power-war, for which their rulers prepared with such marvellous speed? The Russian farming families have the same private fields handed over to them for continuous ownership and their partial subsistence. The central plot, immensely larger though it is than the ninth field of the Chinese sages, is like that ninth field in that it is the State's plot, worked co-operatively by the Russian farming families.

Moreover, the very dangers of the Kolkhoz System, in the pressure that perforce was put upon it for large and speedy returns by the threat of war, will find their solution nowhere better than in a study of Chinese methods. There can be no stronger bond between two huge, neighbouring terrene peoples, the Chinese and the Russians, than this bond of their peasantries.

The Chinese themselves are also in great need of effective bonds with their allies. Anyone who has talked to the Chinese leaders, knows how eagerly they look to the great water engineers of the British Empire and the United States, for instruction to curb the devastating floods of their great rivers, especially the Yellow River; to re-forest their barren catchment areas; to refructify the fertile loess soil, which was the teeming home of their first ancestors, but is now so miserably given over to waste; and in a hundred other ways to assist in the reconstruction of a distraught farming people. No one of the allies, then, has so much to give and so much to receive in the bonds of the soil as the Chinese.

The Russians are the next oldest people of wide dominions to the Chinese. Ivan IV (A.D. 1533-84), Ivan the Terrible, is now heralded as one of the greatest fathers of the Russian people. With ruthless determination, he consolidated the Russian lands, drove out the Mongols, made the Volga into a Russian river, annexed Siberia and made its lands so attractive to the Russian peasants that his successor to power, Boris Godounov, issued an order stopping further migrations of peasant families.

In Chapter 19 we have seen how the Russians had eroded vast areas of their land more or less from the time of Ivan onwards and mainly by the destruction of forests in order to open up new land. They did not even spare the watersheds and their slopes. But the tempo of those days was far slower than that of the modern Russians. Their need of cash for foreign machinery led to the wholesale destruction of Russian and Siberian forests, the timber of which was sold. The Steppe and other and lands did not

offer the same inducement, so, while they were developed and arid lands were reclaimed with singular skill, the forested lands were gravely depleted. To the warning of Professor Kornev, quoted by Messrs. Jacks and Whyte, the two authors added this comment: 'The tractor plough is the enemy of grassland in dry areas, but is indispensable to the propagandist in the modernization of Russian agriculture. Though fore-warned by the experience of other countries, it is difficult to ascertain if the authorities are aware of the danger of mechanization.'

To what degree the Russians have degraded their farmed soil owing to the pressure of the war cannot yet be known, but it must be considerable; it may be, indeed, the greatest loss which they as victors in the war have suffered. That they have much to give and much to receive from their allies in terms of the soil is clear. They can give their experience particularly in the reclamation of arid land; they can give the picture of land developed under an economic system by which the land is developed and farmed without the burden of financial debt, but with the help of their share of the State's revenues; they were about to give in their fourth Five-Year Plan a control of water of a stupendous character, linking together the waters of the north-flowing and south-flowing rivers, as well as individual rivers, and the same with the rivers flowing east and west, perhaps, to use Professor Kornev's words, an act 'of the excessive breaking-up of the topography', the results of which can only be estimated by experience. Yet, on a small scale, Mesopotamia once gave an example of unparalleled success in a linking of rivers.

So the Russians have much to give in terms of the soil. They have also much to receive; especially from the great work of the Americans of the United States in the reclamation and conservation of arid lands, and the re-growth of forests upon watersheds. They have, then, many bonds to forge in terms of the soil.

The last two allies give pictures of the development of farming of land under the dominion of money. The picture that they present has already been sufficiently illustrated in previous chapters as one of progressive destruction of life for temporarily successful financial farming and ranching. They have both pursued the path of Rome with a tempo far exceeding that of Rome. One writer, indeed, has stated that North America would, at the pace set, be turned into a Sahara within a century.

The rude fact is that neither the Americans nor the British are yet civilized in terms of the soil; neither has yet learnt the meaning of the Wisdom of the East. Their use of their dominant money is too often nomadic. They invest it in land or other ventures for *personal profit* and, when profit fails to appear, the pressed and overworked land is abandoned, and finance transfers itself to other ventures, even such as the help of other countries to arm themselves in a preparation to fight the very countries and peoples of the lending financiers themselves. Between the financiers and the nomads, between them and the practitioners of shifting cultivation, there is, indeed, very little difference in principle and in values in terms of the soil. Only the nomads of the past consciously risked much more; they risked their lives, those of their wives and

children, their very existence. The financial nomads, on the other hand, consciously risked very little. They risked much *unconsciously*; their own lives by enemy bombing, those of their wives and children, their homes and the very safety and freedom of the countries in which they lived.

The Americans of North America, and especially the farmers of the United States, have recently become woefully aware and alarmed at the results of nomadism on the soil, of the free cutting down of forests, of over-grazing of the deforested land, of the deep ploughing and mechanical farming of their prairies, of the one-year tenures of farms which enable men to turn fertility into cash and, when this land is degraded, to purchase new land in the great territories of fertile soil which are still theirs. They can ponder over special maps, as we pondered, in Chapter 6, over the map of Asia, and read their fate in its distinctions. Such a special map of the United States is to be found on page 51 of Messrs. Jacks and Whyte's now famous warning to the world. The land of little or no erosion is white, the lands of erosion are graded in shades to indicate its character and degree. One may well shudder at the supreme peril of this great people, if one ponders on the human meaning of this map. The white areas are so few; they seem to cover but a tenth of the map. The rest is eroded lands, according to their kind and their degree, together with mountains, mesas, canyons, and bad-lands. This visual evidence is enhanced by a number of photographs, which terrify the mind, eased though it is by the knowledge that what is happening points to a dread future, to which our own span of life will not extend. 'Not in our time, 0 Lord,' but surely enough, in our time, and to many farmers who have witnessed their farms blown away in storms of dust, 'in our time' with a poignant reality.

Against this tale of home-destruction, with the haunting fear it brings to farmers of the richest country in the world in money, can now be set the supreme achievement of the Tennessee Valley Authority, which has brought about in the valley's inhabitants a veritable resurrection of the human spirit. Mr. Lilienthal does not fail to lay stress on this human change-about and quotes these words from an editorial of a newspaper of Alabama, one of the seven states: 'We can write of the great dam ... of the building of home-grown industry and of electricity at last coming to the farms of thousands of farm people in the Valley. *Yet the significant advance has been made in the thinking of a people*. They are no longer afraid. *They have caught the vision of their own powers*.'

This gift of confidence, one thinks, will be the outstanding contribution of the U.S.A. It has already attracted the keen interest of many governments of South America, Europe, the East and South Africa. But, if the men of the United States have much to give, they have also much to learn from their Allies. From the Russians, they can learn the value of saving the soil from the dominance of money; from the Chinese, the meticulous conservation of the soil, the full rule of return, and agriculture as a national art; and since they now have colonies; from the British, the right and wrong ways of the treatment of tropical colonies, and much else.

The gift of the British to their allies is, indeed, unique in that they, with their extensive empire, have been brought into relationship with all kinds and varieties of terrene conditions. The British have the greatest world-knowledge; ranging from the many millions of India and their imperilment due to their relation of the soil, which I have described elsewhere in my *Restoration of the Peasantries*, 1939; from the vast plains of Canada, which share so fully the most dramatic dangers of the Dust Bowl of the United States; from the disasters that are afflicting her Australasian colonies; from the erosion and degradation of the fertile West Indian Islands, to the little twin islands of the Falklands in the cold waters of the South Atlantic. They are, indeed, fortunate, in comparison to their allies, in that their homeland, set in a temperate sea and served by a humid climate, is almost free from the dangers of erosion. The problems of the reconstruction of its misused soil have not the gigantic proportions of the homelands of the other three.

They, therefore, with the vast varieties of their experience, can act as bonds not only between the Allies, but between them and the whole wide world. Their knowledge of cold, temperate and tropical soils and their peoples is not yet understanding enough for them to be the bond that is needful, but at least they possess the links, through which that knowledge, when recognized and formulated, can be diffused. With their contact with their allies and their contact with many lands and their peoples, with their empire-made neighbours, they, like their great technical achievements, are making the world one.

The meeting of the Four Powers, then, has potentially a far greater meaning than the somewhat hackneyed phrase of a Conference of Powers customarily conveys. It is a meeting, not of tongues and diplomats of the countries they represent, but of the soil of the world and of mankind. It is a meeting, not of four great Powers only, but of four great masses of men all witnessing the rebellion of the soil to its human treatment. They are severally not China, but the Chinese with their forty centuries of farming; not Russia, but the Russians, who first conjoined great tracts of two continents in one whole and who are now testing ways of treating their soils so as to form the basis of a civilization of stability; not the United States, but Americans, people of yet another continent, who are gathering their forces together to stem the terror of an insulted virgin soil; not Britain, but the British, who have been marching upon the path of soil destruction so clearly marked out by Rome, but who, with a like courage and enterprise to that great people, link together most parts of the habitable world. What a conjunction of opportunity! The heart almost stops at the thought that, had the war ended as at one time it seemed it might end, the future of the world would have belonged to the Germans, who, shut in their history between their southern and eastern neighbours and two cold northern seas, have none of the treasures of experience which the Four Allies can bring to reconstruction.

But to the Four Allies are opened the gateways of an opportunity to bless the whole world as never before. Beyond the murk and rubble of the war; beyond the last, bleak resting places of millions of heroic men; beyond the razed homes and shattered towns

of 'the quiet people'; beyond the scorched acres and barren fields; beyond the famines and their reign of death; beyond all this horrible orgy of life-destruction, is seen the vista of the living earth. as the source of the reconstruction of terrene mankind. At the gateways stand sentinels awaiting the password -- THE SOIL.

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*Presented at the "Developments in Thermochemical Biomass Conversion" Conference, Banff, Canada, 20-24 May, 1996.

A WOOD-GAS STOVE FOR DEVELOPING COUNTRIES

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The Biomass Energy Foundation, Golden, CO., USA

Introduction -

A.The Problem

Since the beginning of civilization wood and biomass have been used for cooking. Over 2 billion people cook badly on inefficient wood stoves that waste wood, cause health problems and destroy the forest. Electricity, gas or liquid fuels are preferred for cooking - when they can be obtained, but they depend on having a suitable infrastructure and are often not available in developing countries. In the last few decades, many improved wood stoves have been developed (the Chula, the Hiko, the Maendeleo, the Kuni Mbili, etc.), but the new wood stoves are often more difficult to manufacture, often more heat goes to the stove than to the food, and they do not offer good control of cooking rate. They are not always accepted by the cooks for whom they are developed.[1] Because of the problems of wood cooking, people often cook over charcoal. However, charcoal manufacture is very wasteful of energy and very polluting, so the problems of the wood stove are externalized but not solved.

A.THE SOLUTION

Gas is preferred for cooking wherever it is available. Gas can be made from wood and biomass in gasifiers developed in this century, but these gasifiers are generally too big for home use. A downdraft stove for domestic cooking is now being manufactured in China.[2] We have developed a new "inverted downdraft gasifier" stove shown in Fig. 1. It operates using only natural convection. The rate of gas production and heating is controlled by the primary air supply to the gasifier. As an option, the gasifier can make charcoal with a 20-25% yield. The wood-gas stove consists of an "inverted downdraft gasifier" (shown in Fig. 2) plus a burner to mix air and gas and burn cleanly (Fig. 3). These sections are discussed below. The stove has been started and operated indoors with no exhaust fans and no odor of burning wood. However, we believe that there is still much work to be done in optimizing the stove for various fuels, adapting it to various cooking situations and developing other uses. For that reason we are publishing our preliminary results and hope that others will help adapt these principles to improve world cooking and wood conservation.

WOOD-GAS COOK STOVE

WOOD-GAS COOK STOVE

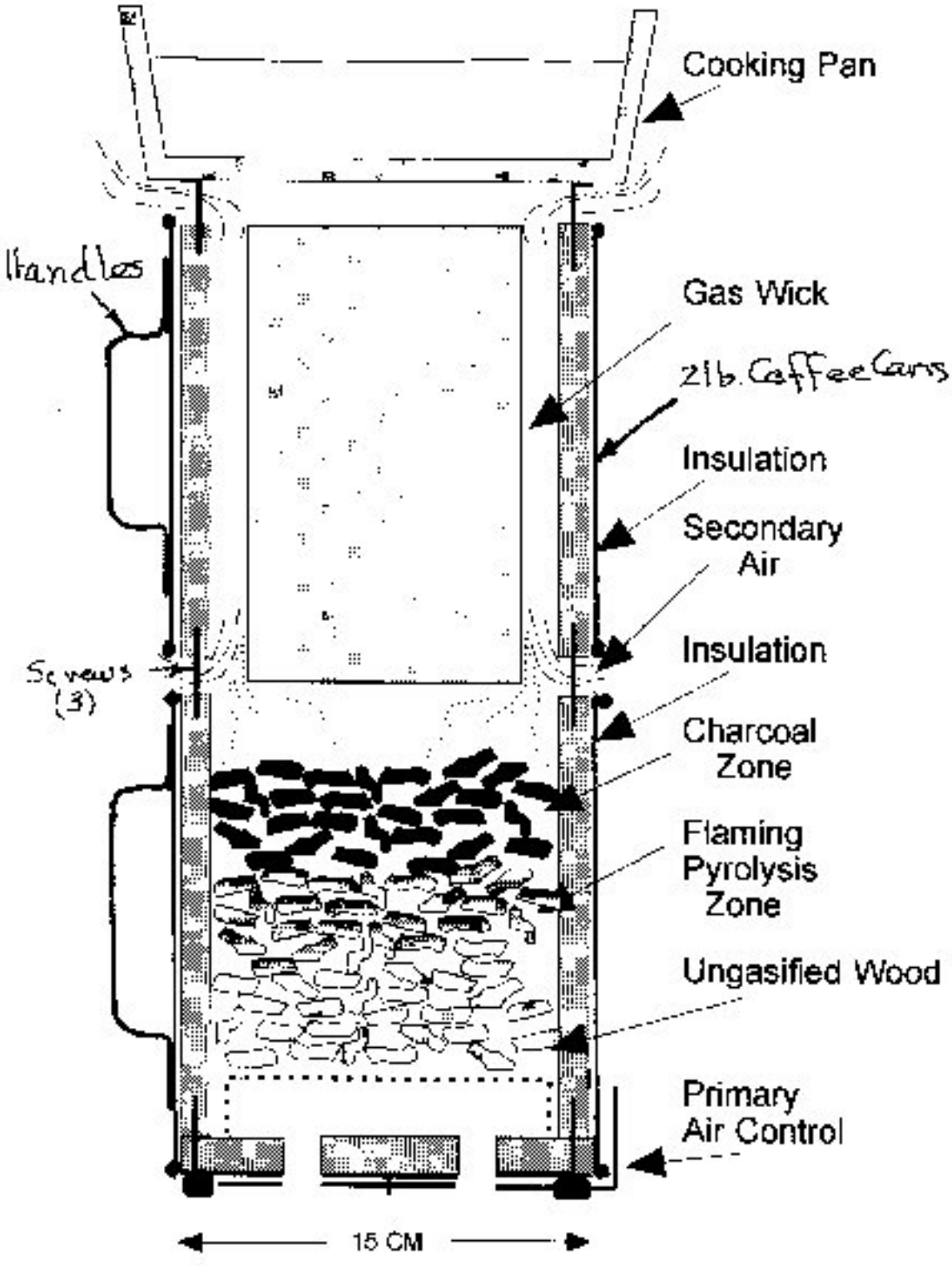

Diagram of a wood-gas cook stove. Typically 300 g of chips or sticks burns 30-45 minutes and makes 25% charcoal, generating 1-3 kW(thermal) depending on setting of the primary air control.

I.CONSTRUCTION OF THE WOOD-GAS STOVE

A.The Inverted Downdraft Gasifier

Wood gasifiers can be classified as: Fixed bed (updraft and downdraft); and fluidized bed. Fluidized bed gasifiers Require high power input, and exact controls and are suitable only for large installations. Updraft gasifiers produce large amounts of tar while consuming the charcoal residue and are not suitable for cooking. Downdraft gasifiers in the 5-100 kW level were widely used in World War II for operating vehicles and trucks because of the relatively low tar levels. [3] In operation, air is drawn down through a bed of burning wood, consuming the volatiles. The resulting gas then passes over the resulting charcoal and is reduced to a low energy fuel gas. However, since hot gases naturally rise, it is necessary to supply power to draw the gases DOWN through the gasifier. In 1985 we developed the "inverted downdraft gasifier" (also called "upside downdraft, or pyrolysing gasifier) operating on natural draft. The name comes from the fact that the fuel charge is lit ON THE TOP, and forms a layer of charcoal there; the flaming pyrolysis zone is below that; the unburned fuel is on the bottom of the pile, and primary air for pyrolytic gasification enters at the bottom and moves UP, forming gas in the flaming pyrolysis zone, as shown in Fig. 2. At that time we built a clean, efficient stove using a jet of compressed air to mix secondary air with the gas and a venturi burner to hold the flame. However, developing country households typically do not have compressed air, so we began development of a natural draft, close coupled cooking gasifier. In 1991 we described a cooking stove based on the inverted downdraft gasifier with natural draft secondary air entering the gasifier above the charcoal zone. The combustion in this stove was relatively clean, but the poor air-gas mixing resulted in a unstable, partly yellow flame. The stove is marketed under the name "GAS-I-FIRE". [4]

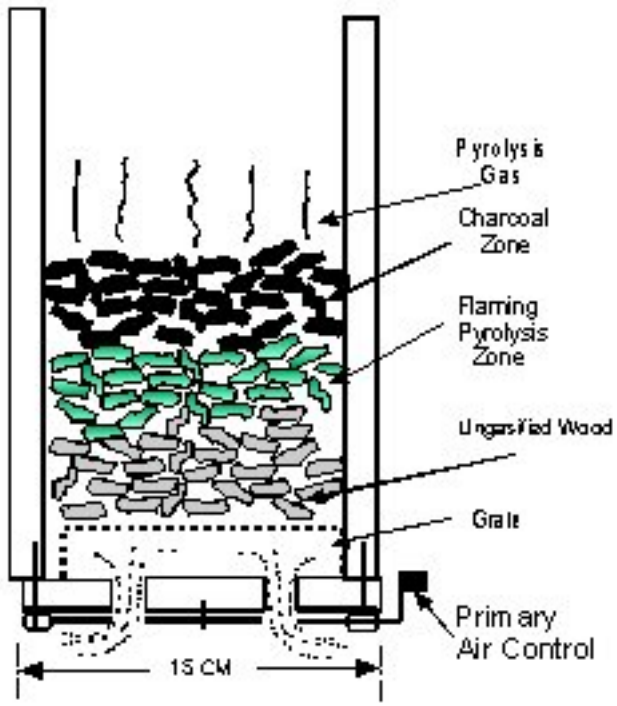

Fig. 2 - Inverted downdraft gasifier made from "riser sleeve", showing primary air inlet, fuel zone, flaming pyrolysis zone and charcoal zone

The inverted downdraft gasifier is operated in batch mode, appropriate for cooking meals. (The

gasifier can also be operated continuously by addition of an auger feed for the fuel at the bottom and an auger to remove charcoal at the top. However, this complicates construction.) We have built several dozen gasifiers from tin cans, pails, stove pipes and "riser sleeves". We have operated gasifiers varying in size from 10 cm (4 in) to 25 cm (10 in) inside diameter. We have built several dozen burner combinations while looking for clean combustion from the burner. The simplest gasifiers are made from 2 lb coffee cans using a "church key" can opener to punch holes in the bottom. Heat losses are high in can stoves, but they are very simple to build. We use metal shears for cutting the metal parts, and sheet metal screws for outside attachments and burner and pan supports. "Riser sleeves" are particularly useful for construction of these stoves. They are made for use in casting molten iron and bronze, so are not affected by the temperatures involved in gasification and combustion. They are available in nominal 3 in to 6 in inside diameter in ½ in steps and in 6 to 10 in inside diameter in one inch steps. All stock sleeves are 30 cm (12 in) tall. As purchased, they are relatively soft and can be cut with saw or razor knife. However, they can also be "rigidized" by application of amorphous silica. They provide excellent insulation, and this is particularly important in small diameter gasifiers. 15 cm OD, 12.5 cm ID sleeves 30 cm tall capable of containing molten steel retail for about $3 in the U.S.[Riser] We believe that our stove can be built for under US$10 in the U.S. or developing countries. A major advantage of the inverted downdraft gasifier is that the rate of gas production depends on the amount of primary air admitted to the bottom. For this reason it is very important to put a tight sealing valve on the bottom which permits a wide range of air adjustments. A simple valve made from 24 gauge sheet metal is shown in Fig. 3.

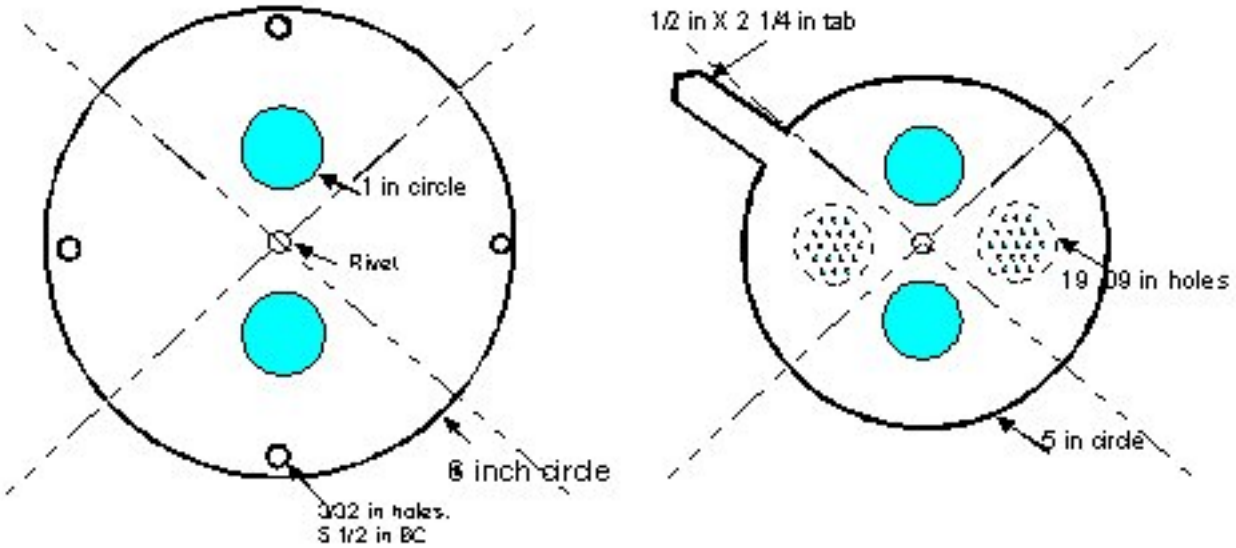

Fig. 3. Details of one type of air valve for coarse and fine control of primary air. We have also constructed very satisfactory stoves from tin cans with riser sleeve liners. Use of the outer can permits addition of simple handles to the gasifier and burner sections.

A.The Wood-Gas Burner

Many burner designs have been tested for the wood-gasifier. The simplest is a series of holes in the gasifier above the level of the charcoal (as discussed for the Hottenroth stove above). However, this does not give good mixing and complete combustion. A better burner consists of a second can mounted a distance of about 1 cm above the first can. Air enters through this annular ring and

mixes with the gas and burns. We have developed a "blue flame" burner (Fig. 4), using a "gas wick" to burn the gas in a very clean manner. In order for the amount of combustion products to have maximum draft, the area must be adjusted. (Conventional gas stoves typically have a ring of fire about 70-120 mm in diameter and about 5 mm across the ring.)

A.Wood-gas Stove Fuels

We have successfully gasified 1-3 cm softwood chips, 1-2 X 10 cm hardwood sticks and 5 mm diameter canes from bushes. The hard woods produce a relatively dense charcoal; the softwoods produce a lighter more friable charcoal.

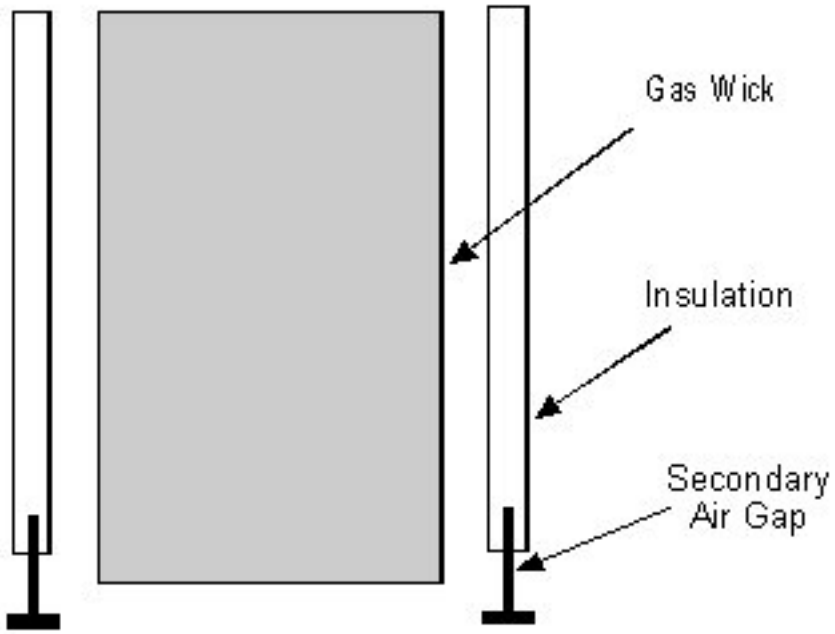

Fig. 4. Annular burner for "blue flame" combustion of wood gas using a "gas wick"

Much of the tests made on the stove used 2 X 1 X ½ cm air dry (about 7% moisture in Denver) Aspen chips in order to have reproducibility . However, we have find the stove operates at least as well on sticks standing vertically. Smaller fuel particles do not permit sufficient air to pass through the bed, and so we have not had success gasifying 0.5 mm wood pellets or corn.

A.Wood-Gas Stove Operation

The gasifier is filled to within 2 cm of the top. It is desirable to have the fire spread rapidly laterally across the surface to provide gas over the whole area, so an easily combustible material, such as dry pine needles, fibers soaked in animal fat or vegetable grease or other "tinder" is placed on top. The tinder is ignited in several places with a match and allowed to burn for a minute or so. When a stable flame is established all around, the burner is placed slowly on top of the gasifier to permit the inside surfaces to become hot. A continuous (smokeless) blue flame was established in 2 minutes and ran continuously for 37 minutes when it went out in Run # 5, p. 92, Book II. The weight of stove (plus the change of weight of 1 liter of water in a pan, added at minute 11) is shown in Fig. 5. It is seen that the stove burned about 12 g/min with full primary air. At 20 min primary air was turned to 20 % and the stove then burned at a rate of 4.5 g/min. 155 g of charcoal

remained at the end of the run.

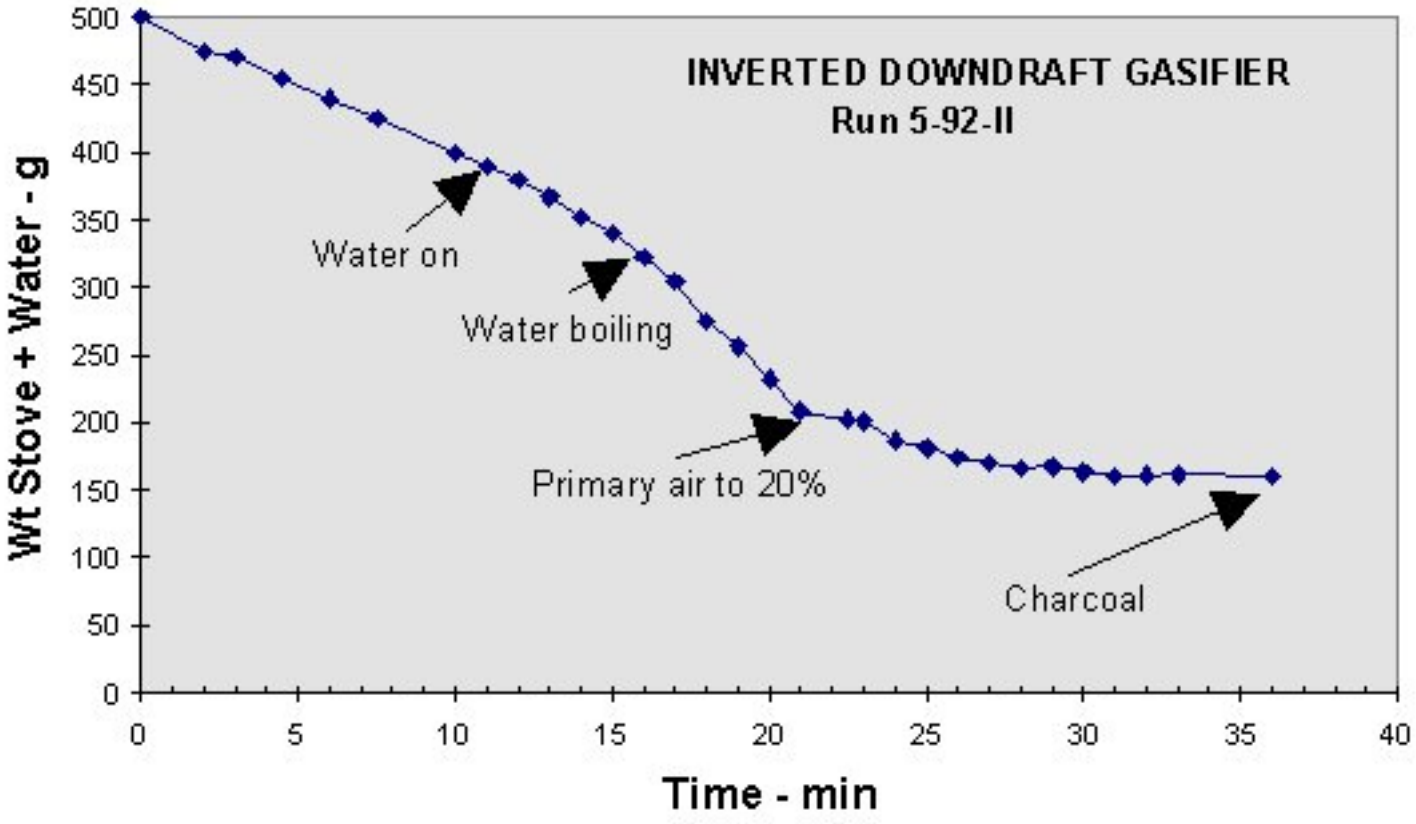

Fig. 5. Typical inverted downdraft gasifier run, No. 5, p. 92, Book II, showing initial stable combustion at 12 g/min, pan on at 11 min, water boiling at 19 min, primary air turned to 20% for simmering at 20 min, and a yield of 150 g charcoal

A.Wood-gas stove emissions

Wood-gas cooking has very low emissions and can be operated indoors with proper precautions once established. However, if the fire is extinguished for any reason the production of smoke and CO continues, so that it is important to be able to extinguish it completely or take it outside. The stove is difficult to extinguish and the bottom air valve must be AIR TIGHT. A pan of water can then be placed on top of the gasifier and there will be no subsequent production of smoke. In a preliminary measurement we have measured the CO level 80 cm above the stove as 22 PPM. The level in the room had no measurable rise. During gasification of wood, if the fire is extinguished the acrid tars in the wood make it unlikely that one would breathe too much CO. However, after the wood is gasified the stove contains hot charcoal and so can be a major source of CO. For this reason it is important to either continue to burn the charcoal or to cut off ALL air to the stove and preserve the charcoal as discussed below.

A.Charcoal manufacture

We find that in a typical run we have a charcoal yield of 10-15% (dry basis). If it is desired to keep the charcoal, it is important that it be possible to close off ALL air to the charcoal after the volatiles are consumed. The valve shown in Fig. 3 should be made of relatively stiff metal to permit a tight closure. The top of the gasifier is closed with a pan over the top. In addition it is

useful to spray water on the top pan and the lower parts of the stove to cool it down to prevent continuing oxidation of the charcoal.

I.STOVE TESTING

Fuel consumption in most of the development runs on the stove were monitored by placing the stove, chimney-burner etc. on a digital balance and recording the weight every minute during the run. In this way it was possible to determine the rate of consumption as a function of primary air setting. A typical chart is shown in Fig. 5. A mass-energy balance was made in a small gasifier connected to a flowmeter and an integrating total flow (Singer) meter. The flow was fixed at 10 scfh from 3 to 30 minutes. The gas was burned in a 10-15 cm high diffusion flame above the gasifier. 135 g of aspen chips 7.8% moisture produced 26.3 g of charcoal (yield =19.5%, 24.2% dry basis). The total air flow was 160 g of air or 30.8 g O2. The mass and energy balances are then:

Chips	+	Water	+	Air	→	Gas	+	Charcoal	
.5		10.5		160		269		26.3	grams
2614						1957		657	kJ

The air/fuel ratio is 1.28. The air/fuel ratio for complete combustion is 6.36, so the equivalence ratio (air consumed/air required for complete combustion) for this test is 0.20 (compared to .25 for equilibrium gasification of dry wood. The gas probably has a higher energy content than conventional gas because no air is required for char conversion. The hat gas energy content will be particularly high because it contains the sensible heat and volatiles as well as the gas.

I.PRELIMINARY MODELLING OF THE WOOD-GAS STOVE

A major advantage of the wood-gas stove is that the gasifier section is stratified and so can be modeled using a simple one dimensional flow scheme. We modeled the conventional stratified downdraft gasifier ("open-top" gasifier, "topless gasifier") and are using the same approach for the inverted downdraft gasifier. The following guidelines are useful for predicting fuel consumption, burn time, stove power and stove size.

Power: The heat content of the gas is ~ 18kJ/g, so consumption of 4-10 g/m produces 1.2-3.0 kWt . (U.S. Electric stoves usually have a 1.5 and a 2.5 kW burner.). The production rate is approximately proportional to cross sectional area. Larger cooking jobs will require larger stoves

Primary Air: The heat for pyrolysis is about 2,000 j/g. Pyrolysis requires 2/3 g air/per g wood or 600 ml air/g wood. 3 kWt requires 6 l air/min

Primary draft: The pyrolysis gas temperature is about 500 °C and so generates a draft of 100 mm-water pressure

Secondary draft: The gas flow around the gas wick is quite complex and work is in progress on calculation of the gas and air flow

I.Conclusions

The wood-gas stove has been started and operated indoors with no exhaust fans and no odor of

burning wood. However, we believe that there is still much work to be done in optimizing the stove for various fuels, determining the effect of moisture, adapting it to various cooking situations and developing other uses. For that reason we are publishing our preliminary results here and hope that others will help adapt these principles to improve world cooking and wood conservation.

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Can a small NGO match a huge Multinational?

March 1999

by Dr.W.S.Hulscher
Chief Technical Adviser, RWEDP

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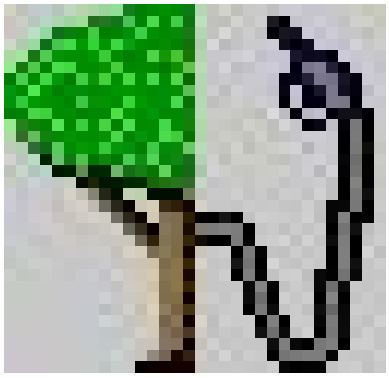

Icono de los biocombustibles.

10 de agosto, D'a Internacional del Biodiesel.

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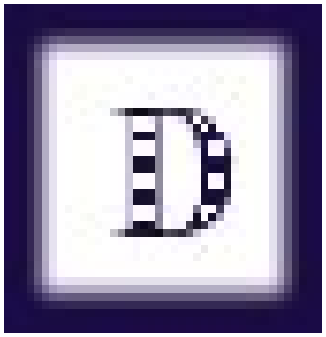

Icono utilizado para representar al diesel (una D rasgada simulando un pi——n mecanico).

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Estos estŽres grasos, pueden mezclarse o no con diesel petrol'fero. Al procentaje de biodiesel puro que se encuentra en el combustible, se le denomina porcentaje de biomasicidad o, simplemente, **bioesteraje.**

As', el Biodiesel B30 tiene un 30 % de bioesteraje, es decir, un 30 % de estŽres grasos y un 70 % de diesel petrol'fero. Este es el tipo de diesel que han de consumir los coches que tengan los manguitos de caucho natural.

El Biodiesel B100 tiene un bioesteraje del 100 %, es decir, s—lo contiene estŽres grasos (no contiene diesel petrol'fero). Este tipo de diesel s—lo lo pueden utilizar los coches que tengan los **manguitos de caucho sintŽtico**. L—gicamente, cambiandole al coche los manguitos de caucho natural por caucho sintŽtico o bien compr‡ndolo de f‡brica con los manguitos de dicho material, se podr‡ consumir este tipo de biodiesel puro.

Puede verse m‡s informaci—n, en lo relacionado con el concepto legal de biodiesel en la secci—n de normativa.

Caracter'sticas del Biodiesel.

Otras ventajas del biodiesel.

Elaboraci—n casera de Biodiesel.

Medici—n de la acidez y cantidad de sosa a usar en la neutralizaci—n

Utilizaci—n de etanol para producir biodiesel

Econom'a del biodiesel.

FABRICACIîN INDUSTRIAL

Reciclaje de aceite vegetal usado.

Asociaci—n de Recicladores de Aceite

Pretratamiento est‡ndar (especialmente indicado para el Aceite Vegetal Usado).

Purificadores de aceite.

M‡quinas procesadoras : la LC-400

NORMATIVA.

Fomento del Biodiesel .

En Espa–a se ha aprobado el **Real Decreto-Ley 6/2000**, de 23 de Junio, de Medidas Urgentes de Intensificaci—n de la Competencia en Mercados de Bienes y Servicios (B.O.E. del 24 pg. 22443), que recoge el siguiente :

Art'culo 6. Utilizaci—n de Biocombustibles.

1. El Gobierno promover‡ la utilizaci—n de los biocombustibles a que se refiere la disposici—n adicional decimosexta de la Ley 34/1998, de 7 de octubre, del Sector de Hidrocarburos,

garantizando, en todo caso, la calidad final de los productos comercializados.

2. Se crea la Comisi—n para el estudio del uso de los biocombustibles presidida por el Ministerio de Econom'a de la que formar‡n parte representantes de l Ministerio de Hacienda; de Medio Ambiente; de Agricultura, Pesca y Alimentaci—n y de Ciencia y Tecnolog'a , que, en el plazo de seis meses desde sus constituci—n, elevar‡ un informe a la Comisi—n Delegada del Gobierno para Asuntos Econ—micos en el que se aborden **las implicaciones fiscales, medioambientales y econ—micas derivadas de la utilizaci—n de dichos biocombustibles, as' como las medidas que puedan ser implantadas para la promoci—n de su uso y, en concreto, las actuaciones en materia de I+D+I dirigidas a conseguir una reducci—n de sus costes de producci—n.**

M‡s normativa

Especificaciones tŽcnicas obligatorias para su comercializaci—n.

ESTçNDARES : DIN 51606 y US ASTM

ORGANIZACIONES privadas y pœblicas de Biodiesel.

(en construccion)

National Biodiesel Board (EE.UU.).

- **Europa**

DG 17 de la Comisi—n Europea (Energ'a).

Isesitalia.

Asociaci—n Italiana de la Industria Oleica.

Instituto Austriaco de Biocombustibles.

British Association for Bio Fuels and Oils.

FABRICACIîN Y COMERCIALIZACION.

Fabricantes en Espa–a y otros pa'ses.

Gasolineras espa–olas que venden biodiesel.

A–ada una estaci—n de servicio a la base de datos de gasolineras que venden biodiesel

UN MOTOR DIESEL SIEMPRE A MANO.

Motores diesel generadores de electricidad, motores marinos (a partir de 4 C.v.) y motocicletas diesel.

NOTICIAS

Piden al Gobierno que fomente el uso de energ'as renovables

Madrid, 20 nov (EFE).- El PP inst— al Gobierno a desarrollar estudios, proyectos y medidas concretas que fomenten el uso de energ'as renovables en Espa–a, especialmente de la biomasa, segœn una moci—n debatida ayer en el pleno del Senado.
JosŽ Ram—n Bustillo, encargado de defender la petici—n popular, dijo que el Plan de Fomento de las Energ'as Renovables puesto en marcha por el Gobierno obtuvo en su momento el aplauso de todos los sectores, incluida la Asociaci—n Espa–ola de Productores de Energ'as Renovables, y lo consider— como un punto de partida s—lido para empezar a desarrollar este tipo de energ'as.
Bustillo explic— que Espa–a depende de la importaci—n energŽtica en m‡s de un 70 por ciento del total de la energ'a producida, y a–adi— que las energ'as renovables suponen "s—lo el 6,3 por ciento del total de la energ'a que utilizamos; un retraso inexplicable dado nuestro potencial en d'as de sol y viento".
En defensa del uso de la biomasa como fuente de energ'a, el senador popular dijo que "es la fuente renovable de mayor potencial en Espa–a" y aclar— que sus recursos se cuantifican en 25,7 millones de toneladas equivalentes de petr—leo, lo que supone, a–adi—, "una cantidad superior a todos los consumos energŽticos de toda la industria espa–ola".
Asimismo explic— que la biomasa es "la energ'a solar convertida por la vegetaci—n en materia org‡nica" y puede recuperarse "por combusti—n directa o transformando la materia org‡nica en otros combustibles" como bioalcohol, biodiesel, estiŽrcol y le–a.

Ethanol - As A Fuel

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Module 1: Introduction to Ethanol

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Module 4: The Environment

Module 5: Ethanol: The Fuel

Glossary

Projects and Activities for Students

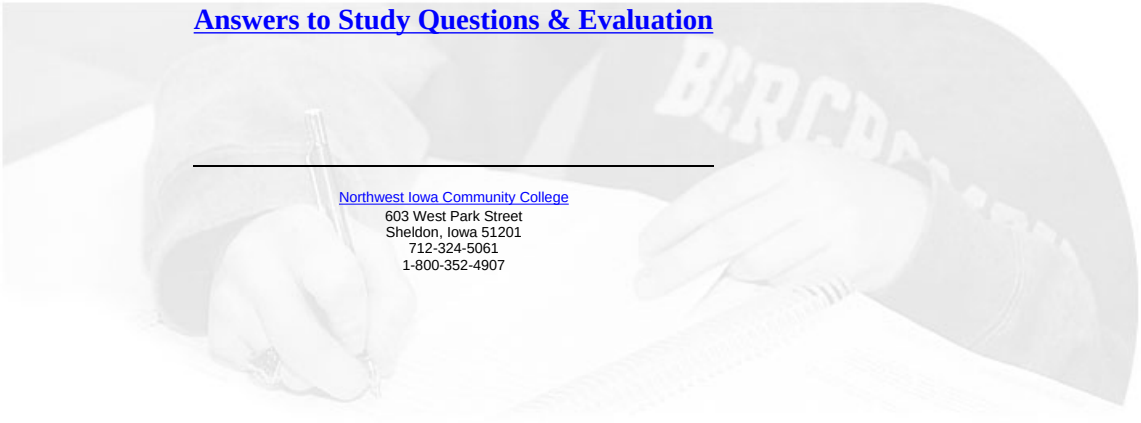
Ethanol Information Overview

Who to Contact?/Internet Web Sites/References & Additional Reading

Ethanol Evaluation

Answers to Study Questions & Evaluation

Northwest Iowa Community College
603 West Park Street
Sheldon, Iowa 51201
712-324-5061
1-800-352-4907



The Key Centre for Polymer Colloids is established and supported under the Australian Research Council's Research Centres Program.

Relation to Syllabus

The information presented on this page is designed to be used by teachers to show the links between the material in this trail and the NSW HSC Chemistry (Stage 6) Syllabus. Relevant excerpts of the Syllabus are shown on this page and a copy of the full Syllabus may be downloaded from the Board of Studies website in PDF format. Additionally, teachers are advised to take note of the Board Bulletins as they contain up-to-the-minute important information.

9.2 The Identification and Production of Materials

Contextual Outline

Humans have always exploited their natural environment for all their needs including food, clothing and shelter. As the cultural development of humans continued, they looked for a greater variety of materials to cater for their needs.

The twentieth century saw an explosion in both the use of traditional materials and in the research for development of a wider range of materials to satisfy the specialist needs of space travel and the information technologies. Added to this was a reduction in availability of the traditional resources to supply the increasing world population.

Chemists and chemical engineers continue to play a pivotal role in the search for new sources of traditional materials such as those from the petrochemical industry. As the fossil organic reserves dwindle, new sources of the organic chemicals presently used have to be found. In

addition, chemists are continually searching for compounds to be used in the design and production of new materials to replace those that have been deemed no longer satisfactory for needs.

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3. Other resources, such as ethanol, are readily available from plants. Such renewable resources will be of increasing importance as fossil fuel reserves are depleted

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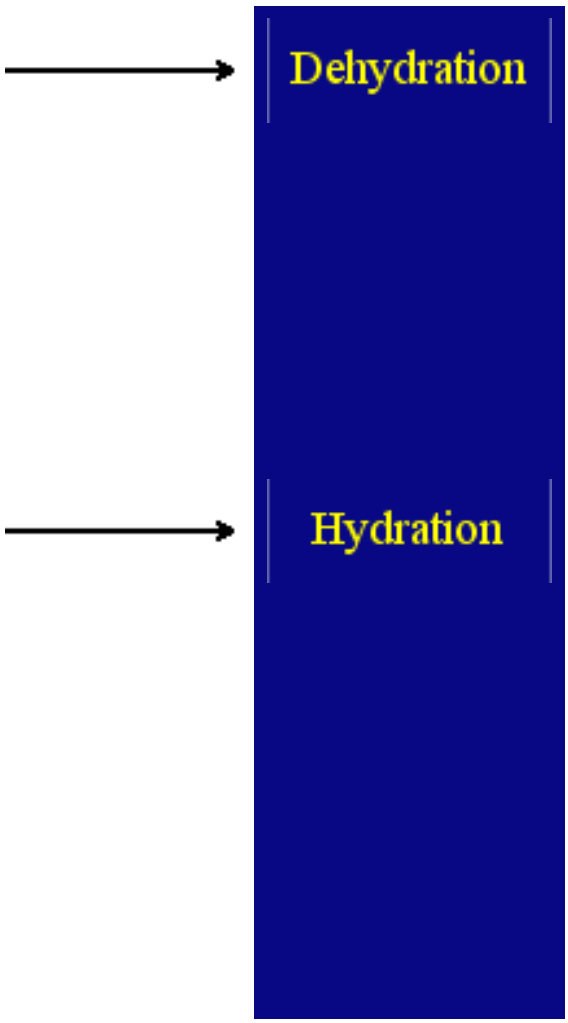
Students learn to:

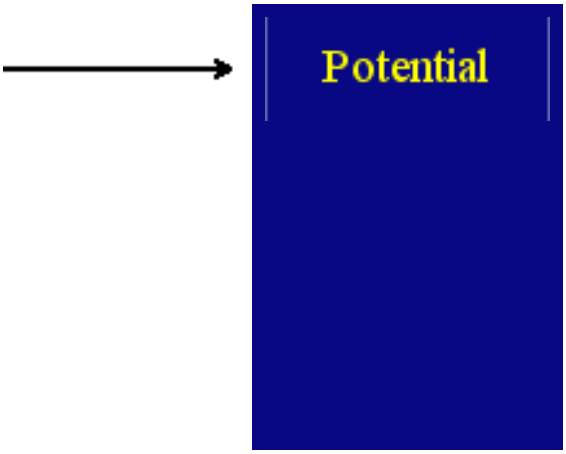
- describe the dehydration of ethanol to ethene and identify the need for a catalyst in this process and the catalyst used
- describe the addition of water to ethene resulting in the production of ethanol and identify the need for a catalyst in this process and the catalyst



used

- describe the uses of ethanol as a solvent and relate this to the polar nature of the ethanol molecule → Solvent
- outline the use of ethanol as a fuel and explain why it can be called a renewable resource → Fuel
- describe conditions under which fermentation of sugars is promoted → Fermenting I
- summarise the chemistry of the fermentation process → Fermenting II
- define the molar heat of combustion of a compound and calculate the value for ethanol from first-hand data → Combustion

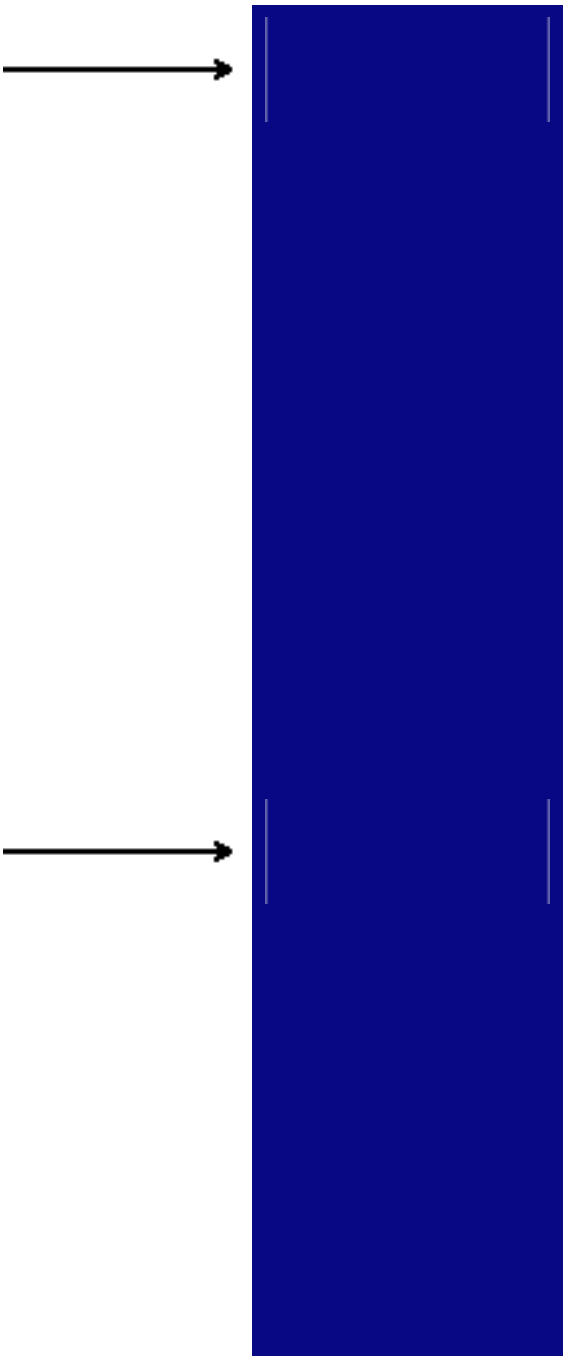
- assess the potential of ethanol as an alternative fuel and discuss the advantages and disadvantages of its use



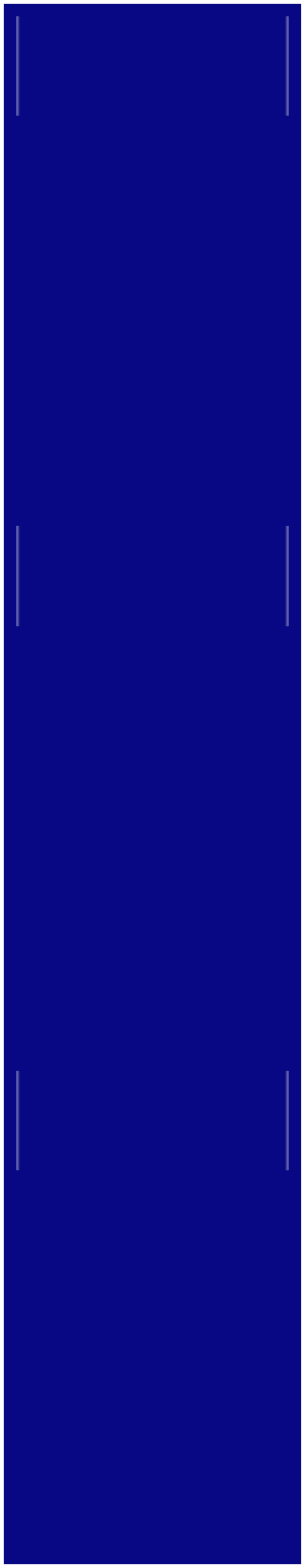
Students:

- process information from secondary sources such as molecular model kits, digital technologies or computer simulations to model
  - the addition of water to ethene
  - the dehydration of ethanol

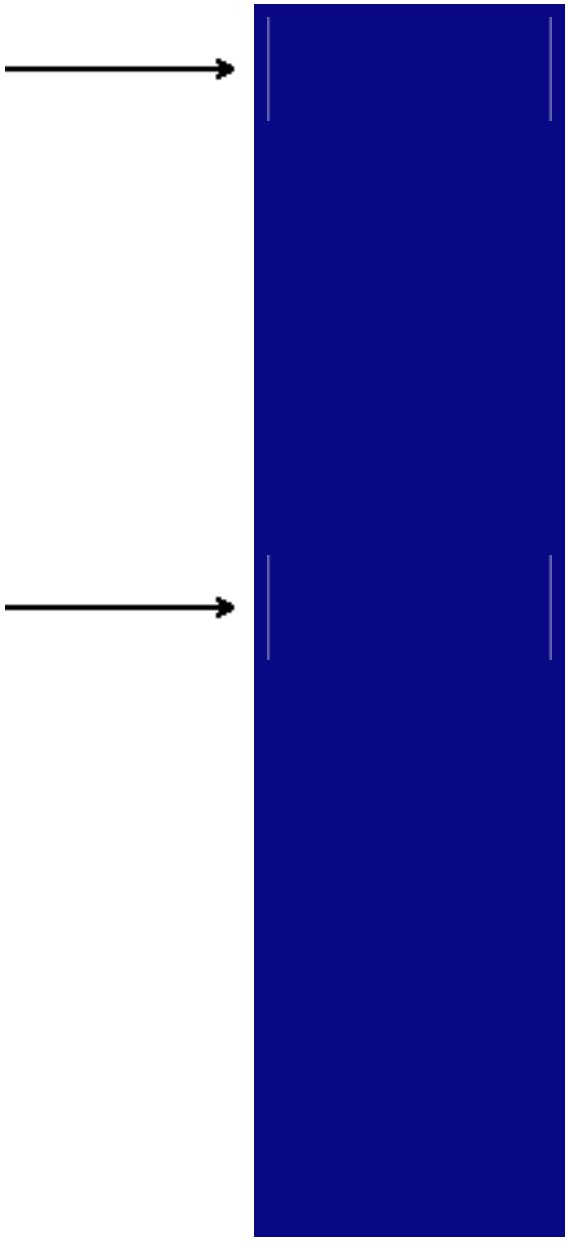
- plan, choose equipment and perform a first-hand investigation to gather information about the range of substances which can be dissolved by ethanol



- process information from secondary sources to summarise the processes involved in the industrial production of ethanol from sugar cane
- process information from secondary sources to summarise the use of ethanol as an alternative car fuel, evaluating the success of current usage
- solve problems, plan and perform a first-hand investigation to carry out the fermentation of sucrose and monitor mass changes



- present information from secondary sources by writing a balanced equation for the fermentation of glucose to ethanol



- identify data sources, choose resources and perform a first-hand investigation to determine and compare heats of combustion of at least three liquid alkanols per gram and per mole

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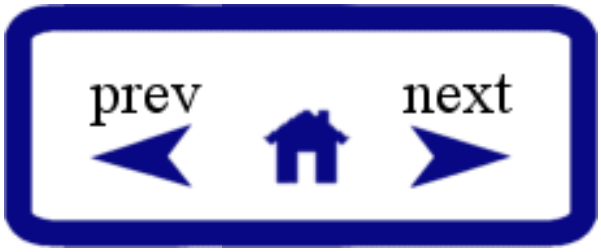


Download Biomass Vehicle PDF

EYA Biomass Vehicle

Building the 'Stirly, the Little Engine that CAN'

INTRODUCTION

Stirly was designed as an educational model to demonstrate how biomass fuels (clean and renewable fuels made from plant materials) can be used to power vehicles. It is meant to inspire people into thinking about alternatives to fossil fuel energy. It is also meant to promote a very exciting and promising sustainable technology for not only locomotion, but also heating, cooling, and power generation, namely, the Stirling engine.

THE STIRLING ENGINE

The Stirling engine, invented in 1816 by Rev. Robert Stirling, is one of the most efficient, quiet, non-polluting, and versatile engines ever invented.1 It can run on virtually any fuel, including natural gas, propane, diesel, gasoline, crude oil, flare gas, solar, geothermal, biomass, hydrogen, landfill gas and waste heat.2 This wide variety of suitable fuels ensures that energy from Stirling engines can be produced both locally and sustainably.

HOW A STIRLING ENGINE WORKS

A Stirling engine is an external combustion engine, or a heat engine. In contrast to traditional internal combustion engines that we see in automobiles, which take in fuel and air, a Stirling engine works differently. It doesn't take in any fuel or air. Instead, a Stirling engine contains a sealed-in amount of gas (usually pressurized helium or hydrogen) that is used over and over to power itself. Rather than burning fuel inside, a Stirling engine uses external heat to expand its contained gas and push against its pistons. The engine then recycles the same captive gas by cooling and compressing it, then re-heating it again to expand and work the pistons. (For a detailed explanation of how a Stirling engine works, see Sources section.)

• very small glass bead – ensure the hole is just barely large enough to let the fishing thread smoothly pass through it [art supplies store]

• fishing thread – 20cm min.

• 4 wheels – dimensions? (find order booklet)

• 2 pulleys -dimensions? (find order booklet)

• about 20 cm of thin copper wire

• hose clamp – large enough to tighten around can

• fondue burner (about 9cm wide and 4 cm tall) [kitchen supply store]

• 99% isopropyl alcohol (biomass fuel-is it truely?) [pharmacy store]

• wide rubber band – large enough to tightly fit around can

• the rubber elastics from 2, cheap dust masks

• paper clip

• 2 thumbtacks

• 8 round-head wood screws – about 9/64" diameter and 2cm long

• 4 bolts & nuts – between 5/32" and 11/64" diameter, and about 1cm in length

• plain wood glue or balsa wood glue

• duct tape and/or 'Superglue'

• sewing pin or safety pin – small enough to pass through the glass bead

• fine-point marker and pencil

• cotton swab

[Fig 1: Detailed Front View of Stirly]

STIRLY'S TIN CAN STIRLING ENGINE

Stirly uses a very simplified Stirling engine made from a few parts that can be found at most hobby shops and hardware stores. Its working gas is simply air, sealed in a tin can with the use of a rubber balloon on top. Its fuel source is isopropyl alcohol (rubbing alcohol) – a biomass fuel.

Stirly's design was inspired by Mr. Saburo Tsucchida's tin can Stirling engine design plans. (See Sources section) Stirly was designed and built by Eesmyal Santos-Brault, an employee of the Environmental Youth Alliance (EYA), Vancouver, BC.

Materials needed:

• plastic sheet (Plexiglas, lexan, or Lucite) – 3/16" thick [hardware store]

• tin can – preferably without ribs along sides

• about 6.5 cm diameter, 10cm tall - the perfect can we found was no name brand "Pieces & Stems Mushrooms", 284ml (10fl oz), found at corner store on Hastings at Abbott, Vancouver.

• balsa wood - 1cm thick (300 cm^2 min. area) [hobby shop]

• 3/4" (about 2cm) thick piece of wood (about 2 x 6 x 9.5cm) – see Fig. 3

• wooden dowel – about 6mm diameter [hobby shop]

• 16 gauge floral stem wire, or other such wire that's bendable, yet holds its shape – at least 30cm long (buy a few of them 'cause you'll probably wreck 2 or 3 before you get it right)

• 9" balloons (you need a few, in case of mistakes and for replacement)

• plasticine [art supplies store/hobby shop]

• hollow plastic tube – _" outside

Tools Needed:

• 2 1/2 " hole saw

• power drill

• imperial drill bit set

• scissors

• Plexiglas knife, or exacto-knife

• can opener

• needle nose pliers

• regular pliers

• hot glue gun + glue stick

• hand saw

• vice

• file, or medium sandpaper

• work gloves and safety goggles

• large drafting triangles

• metric and imperial ruler(s) – metal, if possible

• work bench

• 2 – 3 small C-clamps

• awl or center punch – tool for making indentations

• multi-bit screw driver

• tin snippers – for cutting thin metal

• BBQ lighterNOTE: Read over all instructions as well as safety tips before building.

diameter; 1/8" inside diameter; at least 30cm long

• "All Round" steel strapping – 1/2" [hardware store]

| Materials & Tools | Step 1 | Step 2 | Step 3 | Step 4 | Step 5 |

| Step 6 | Step 7 | Step 8 | Step 9 | Step 10 | Step 11 |

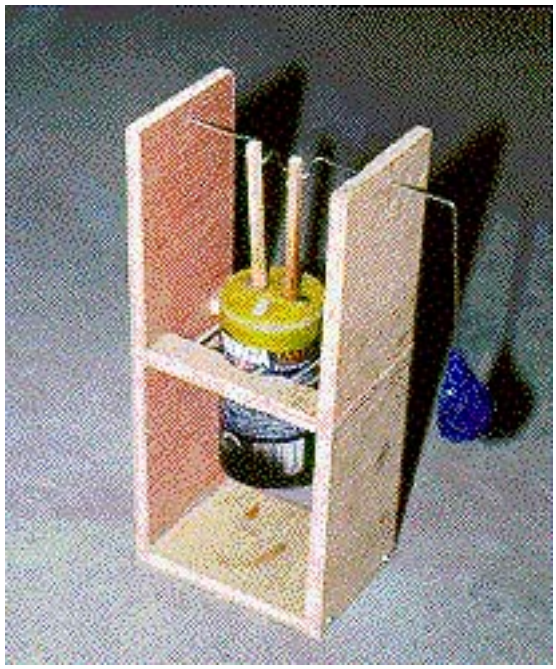
| Step 12 | Step 13 | Step 14 | Step 15 | Tips | Sources |

Let's Build Model Stirling Engines

Let's Build a Can Stirling Engine

To Japanese Page

The Can Stirling engine can rotate using a candle as the heat source. This engine is constructed with very simple materials. There are a can, a balloon, a wood board and others.



A Can Stirling Engine

(This engine was proposed by Mr.Saburo Tsucchida.
He is teacher of Kasukabe technical high scool.)

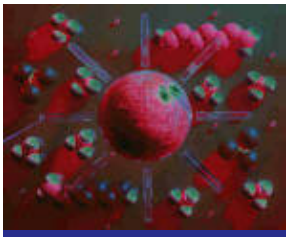
- Step 1 --- Material Preparation and Structure
- Step 2 --- Cut a Wood Board
- Step 3 --- Make a Wood Piston
- Step 4 --- Make a Diaphragm
- Step 5 --- Make Connecting Rods and a Crank Shaft
- Step 6 --- Construct a Diaphragm and Crank Mechanism
- Step 7 --- Construct the Frame
- Step 8 --- Construct a Wood Piston and Crank Mechanism

- Step 9 --- Fit Up a Can
- Step 10 --- Let's Try to Move

Return to 'Let's Build Model Stirling Engines'

Go to Stirling Engine Home Page

Koichi Hirata



Alcohol, Chemistry and You
Gatorade
NutraSweet
Silicones
Nuclear Chemistry and the Community
Cisplatin and Cancer
Refrigerants for the 21st Century
Olestra
Drug Pathways and Chemical Concepts
Fuels and Society -- Chemistry and History of Automotive Fuels
Fuels and Society Sixty Years of Tetraethyllead
Fuels and Society -- How Lead was Finally Removed from Gasoline Fuel Cells

Chemistry of How Things Work

and

Decisions - Good and Bad - that Bring Chemistry into Our Life

Chemcases.com is a National Science Foundation supported curriculum development project

What Is Chemcases?

Twelve case studies of chemistry in the products we use and the situations we meet. ChemCases.com helps you evaluate the decisions behind these products and situations.

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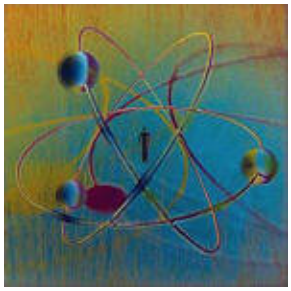
ChemCases.com shows how the chemistry of food relieves our hunger, the chemistry of water and Gatorade and soft drinks and beer and wine takes the edge off our thirst.

It shows how our drugs and medications work by chemical reactions; it is the chemistry of fuels that powers what we drive and fly; it is chemistry that gives electricity from nuclear and more traditional power sources; chemical synthesis provides our plastics.



And it is the complexities of chemistry that converts useful materials into pollutants, makes some users of alcohol into abusers and addicts some of us to innocent looking but destructive white powders.

Application

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Current Initiatives

The Secret History of Lead: A Special Report

[View PDF] (Please be advised that the timeline and press release are not accessible in this PDF file.)

by **Jamie Lincoln Kitman**
The Nation
Reprinted with permission from the March 20, 2000 issue of *The Nation.*
[View Timeline] [View Press Release]

The next time you pull the family barge in for a fill-up, check it out: The gas pumps read "Unleaded." You might reasonably suppose this is because naturally occurring lead has been thoughtfully removed from the gasoline. But you would be wrong. There is no lead in gasoline unless somebody puts it there. And, a little more than seventy-five years ago, some of America's leading corporations--General Motors, Du Pont and Standard Oil of New Jersey (known nowadays as Exxon)--were that somebody. They got together and put lead, a known poison, into gasoline, for profit.

Lead was outlawed as an automotive gasoline additive in this country in 1986--more than sixty years after its introduction--to enable the use of emissions-reducing catalytic converters in cars (which are contaminated and rendered useless by lead) and to address the myriad health and safety concerns that have shadowed the toxic additive from its first, tentative appearance on US roads in the twenties, through a period of international ubiquity only recently ending. Since the virtual disappearance of leaded gas in the United States (it's still sold for use in propeller airplanes), the mean blood-lead level of the American population has declined more than 75 percent. A 1985 EPA study estimated that as many as 5,000 Americans died annually from lead-related heart disease prior to the country's lead phaseout. According to a 1988 report to Congress on childhood lead poisoning in America by the government's Agency for Toxic Substances and Disease Registry, one can estimate that the blood-lead levels of up to 2 million children were reduced every year to below toxic levels between 1970 and 1987 as leaded gasoline use was reduced. From that report and elsewhere, one can conservatively estimate that a total of about 68 million young children had toxic exposures to lead from gasoline from 1927 to 1987.

* * *

How did lead get into gasoline in the first place? And why is leaded gas

On our Site:
- Join the Network
- Search the Network Directory
- Advocacy Tools
  - Current Initiatives
  - Best Practices
  - Tools for Prevention
  - Resources for Capacity Building
  - Working with the Media
  - Working with Policymakers
- Resource Center
- Policy & Legislation
- Publications
- About the Network

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send it

still being sold in the Third World, Eastern Europe and elsewhere? Recently uncovered documents from the archives of the aforementioned industrial behemoths and the US government, a new skein of academic research and a careful reading of that long-ago period's historical record, as well as dozens of interviews conducted by The Nation, tell the true story of leaded gasoline, a sad and sordid commercial venture that would tiptoe its way quietly into the black hole of history if the captains of industry were to have their way. But the story must be recounted now. The leaded gas adventurers have profitably polluted the world on a grand scale and, in the process, have provided a model for the asbestos, tobacco, pesticide and nuclear power industries, and other twentieth-century corporate bad actors, for evading clear evidence that their products are harmful by hiding behind the mantle of scientific uncertainty.

This is not just a textbook example of unnecessary environmental degradation, however. Nor is this history important solely as a cautionary retort to those who would doubt the need for aggressive regulation of industry, when commercial interests ask us to sanction genetically modified food on the basis of their own scientific assurances, just as the merchants of lead once did. The leaded gasoline story must also be read as a call to action, for the lead menace lives.

>>>

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