Introduction to Soil and Water Conservation Practices

Practical Guide to Dryland Farming I

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PRACTICAL GUIDE
TO DRYLAND FARMING

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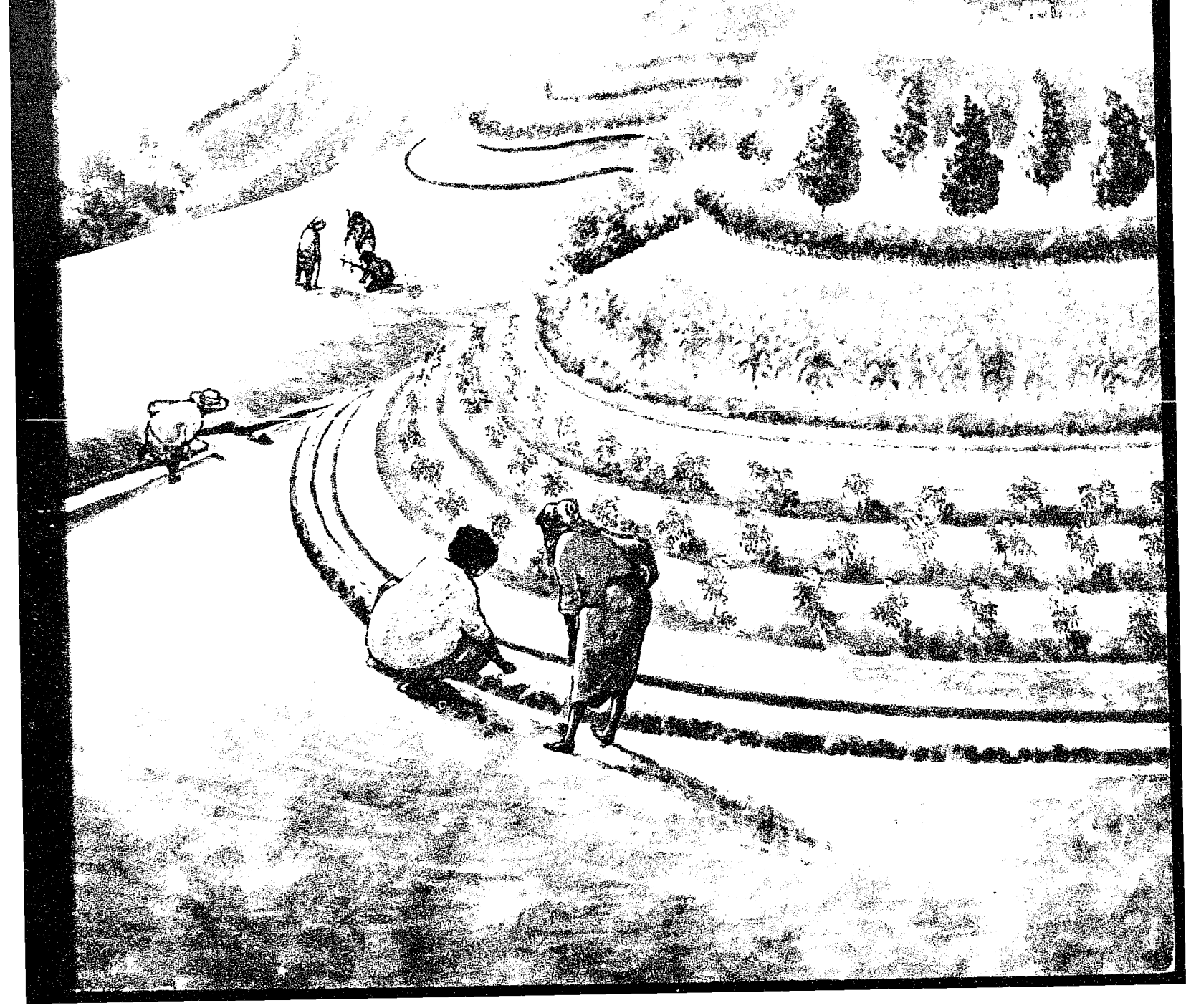
INTRODUCTION TO SOIL AND WATER CONSERVATION PRACTICES



INTRODUCTION TO SOIL AND WATER CONSERVATION PRACTICES

Introduction to Soil and Water Conservation Practices is the first title in the *Practical Guide to Dryland Farming Series,* a set of booklets initially put together for upland farmers in the Nusa Tenggara Provinces of southeastern Indonesia. Originally published in 1985, this revised edition includes updated information on soil and water conservation technologies. Many of the revisions are based on the experiences of upland farmers in East Nusa Tenggara who have been using the practices in the original booklet on their own farms over the last few years.

Other booklets in this expanding series cover aspects of dryland farm management such as contour farming with living barriers, planting tree crops, animal husbandry, integrated farming, and on-farm experimentation.

The Practical Guide to Dryland Farming Series is collaborative effort between World Neighbors, Studio Driya Media and Yayasan Tananua in Indonesia, with additional input from several other grassroots organizations working throughout the region. These booklets were designed to be used together with farmers, extension agents, or program personnel who are already somewhat familiar with the practices described. The methodologies discussed are specifically applicable to the conditions found in the semi-arid regions of southeastern Indonesia; some of the practices, therefore, may not be applicable in areas with different climates, soils, or farming traditions.

If you have any questions about the material contained in this publication or others in the *Dryland Farming Series,* please contact World Neighbors. Comments and suggestions are welcome as well!

English versions* of the *Practical Guide to Dryland Farming Series* can be ordered from:

World Neighbors
5116 North Portland Avenue
Oklahoma City, OK 73112
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Indonesian language versions can be ordered from:

Studio Driya Media
Jl. Hariangbanga No. 2 pav
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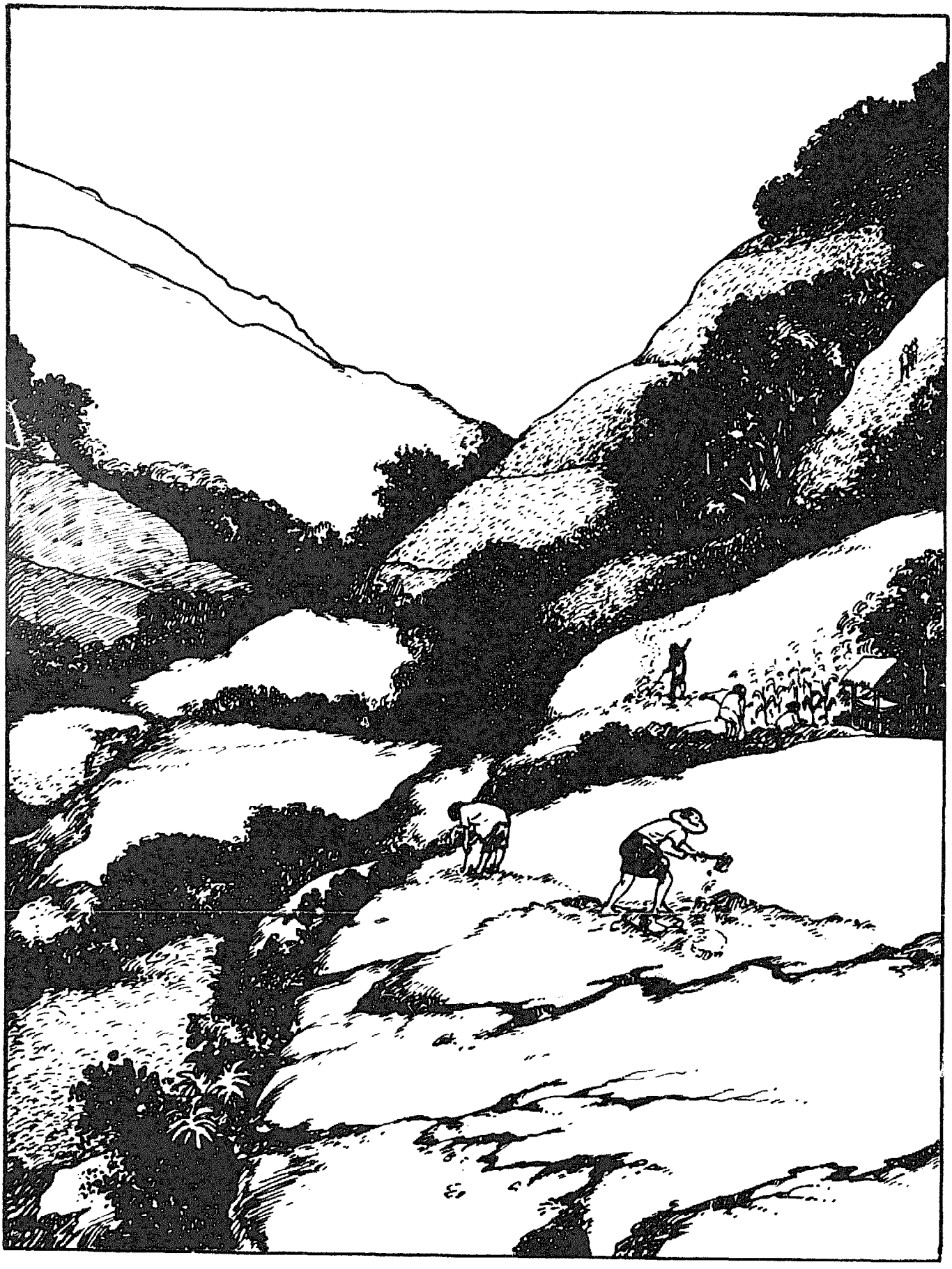
*Not all booklets in the series are available in English.



Farmers in upland areas throughout the world face similar problems. They generally cultivate fields on moderately to severely sloping land with thin, easily eroded soils in areas where the rainy season is short but intense.

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In facing these unique challenges, farmers have worked over many years to develop farming methods that are appropriate to these conditions. They begin by opening new farms in the forest, or in areas covered with underbrush.

Soils under forest or brush, particularly after they are burned, are usually quite fertile. This is because the accumulation of leaves that fall and decompose over the years forms a thick layer of humus. This layer of humus, along with the roots of trees and other plants, holds the rainfall so that it is absorbed into the soil.

These farms can be cultivated for a few years with reasonable crop yields. But, after that, yields begin to fall as the soil fertility is used up by the crops and the remaining fertile top soil is carried away by rain water.

When this happens, new land must be cleared to plant, while the old fields are abandoned until their fertility returns. In former times, this method of opening new fields every few years promised satisfactory yields because there was plenty of forest and open land available to clear.

...But in recent years, it has become difficult to practice this type of farming effectively because land for new fields is getting harder to find. The growing rural population means more people need land than before, while the traditional system of "shifting cultivation" requires a large amount of land for each family.

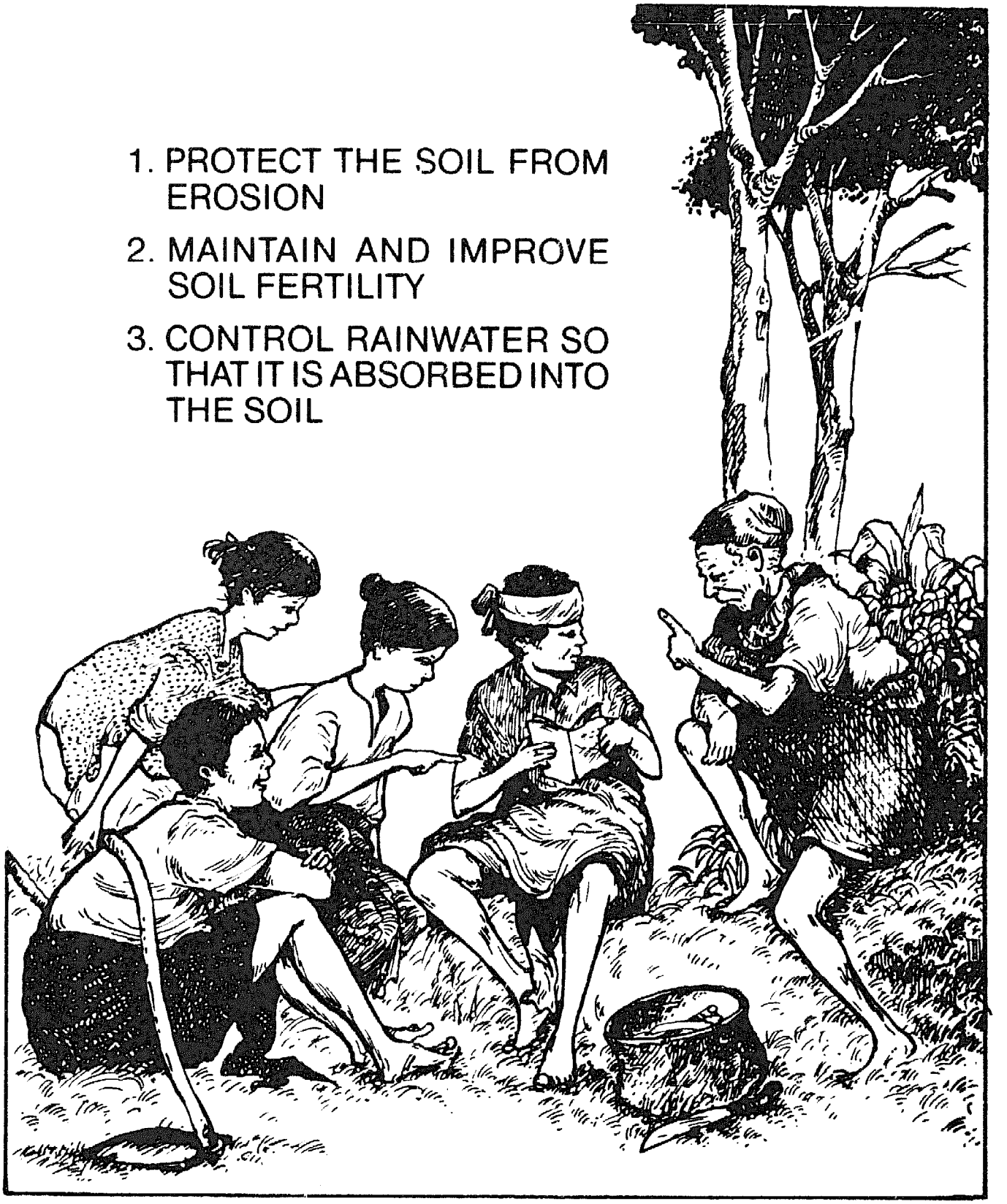
Farmers must go further and further from their village to find forest lands that are still fertile. In addition, the government has set aside a part of the remaining forest area as "protected areas" in order to protect the sources of water or "watershed". Farmers are not allowed to farm or cut trees in these conservation forests.

Aside from this, farmers who used to grow only enough food to feed their own families are now adopting new farming practices to develop additional sources of income. Money is now needed for things which were not available or perhaps considered unnecessary in the past: school fees, medical expenses, household goods, etc.

All of these changes force upland farmers to cultivate the same piece of land continuously, using improved farming practices that can result in better yields. Farmers themselves can adapt and improve upon many of the farming techniques that have been handed down through the generations.

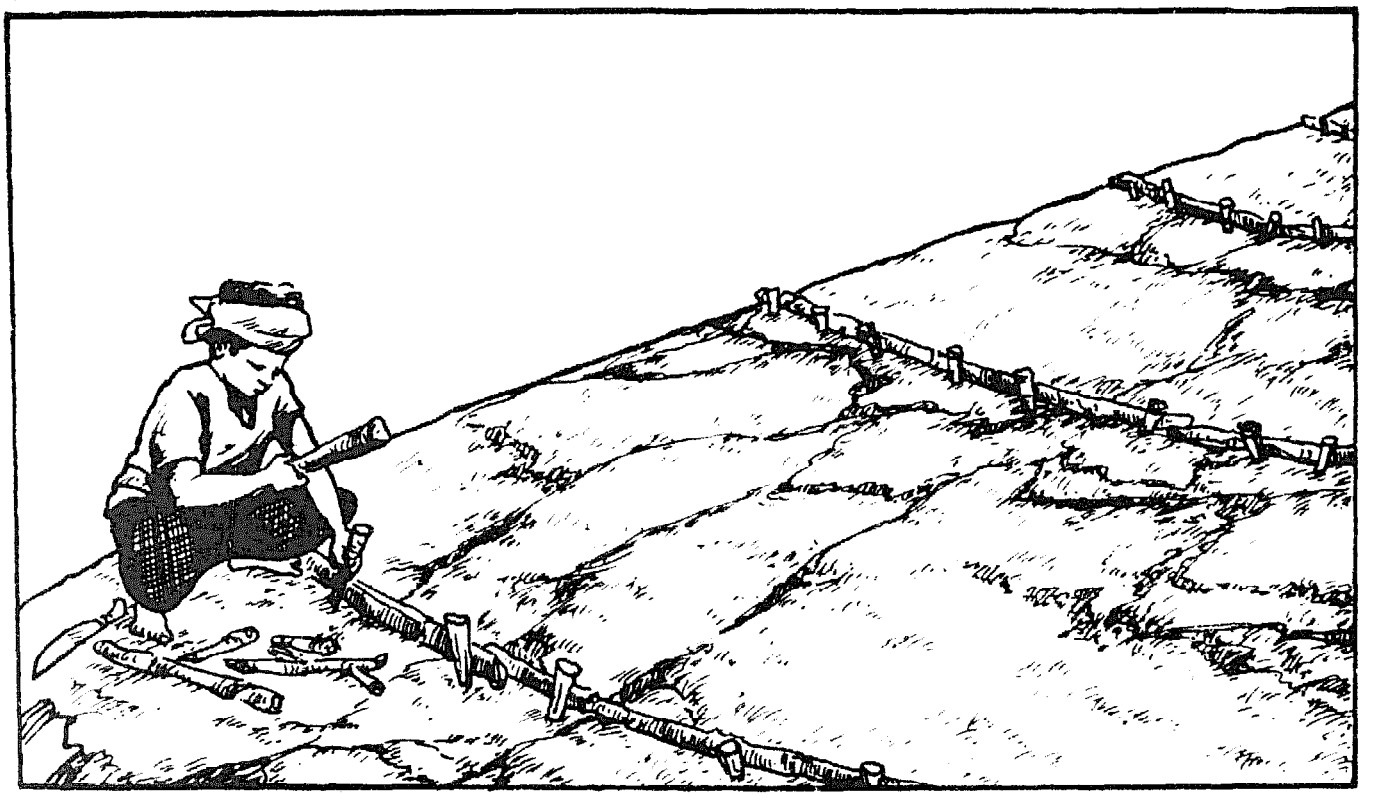
Even though the methods that are used now differ from those used in the past, the principles remain the same:

1. PROTECT THE SOIL FROM EROSION
2. MAINTAIN AND IMPROVE SOIL FERTILITY
3. CONTROL RAINWATER SO THAT IT IS ABSORBED INTO THE SOIL

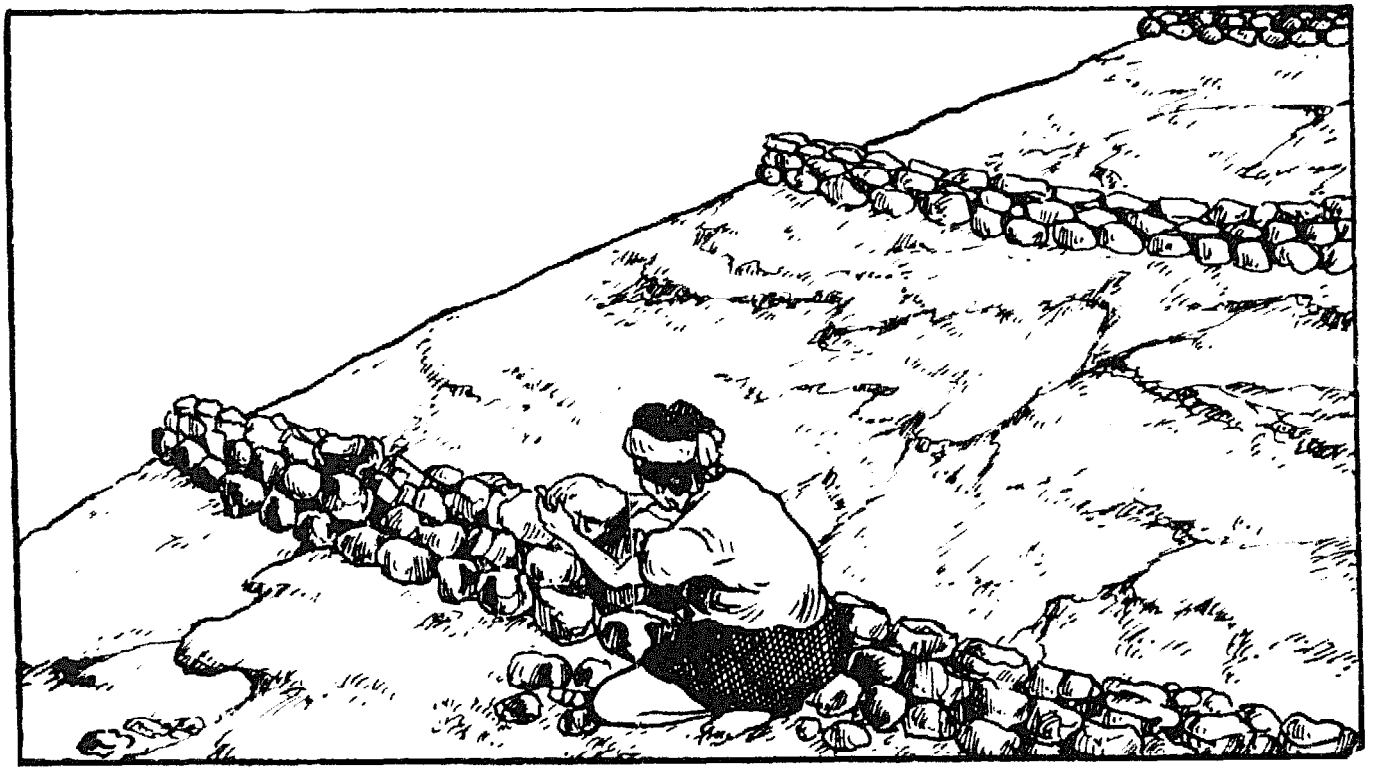


This booklet together with other booklets in *Dryland Farming Series* covers practices developed by farmers in many parts of the world for improving farming methods. We can learn from them and consider their methods in light of our own experience and the conditions found on our individual farms.

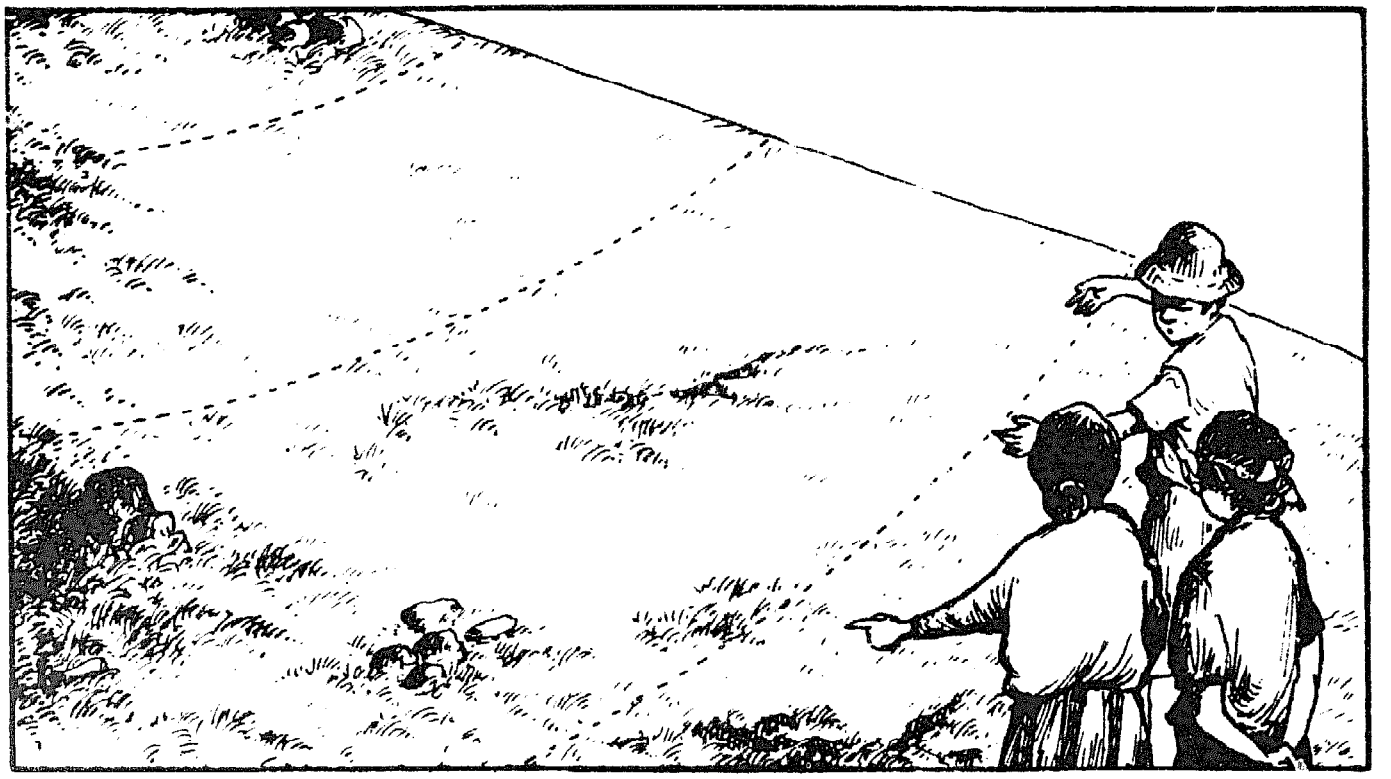
8 BARRIERS



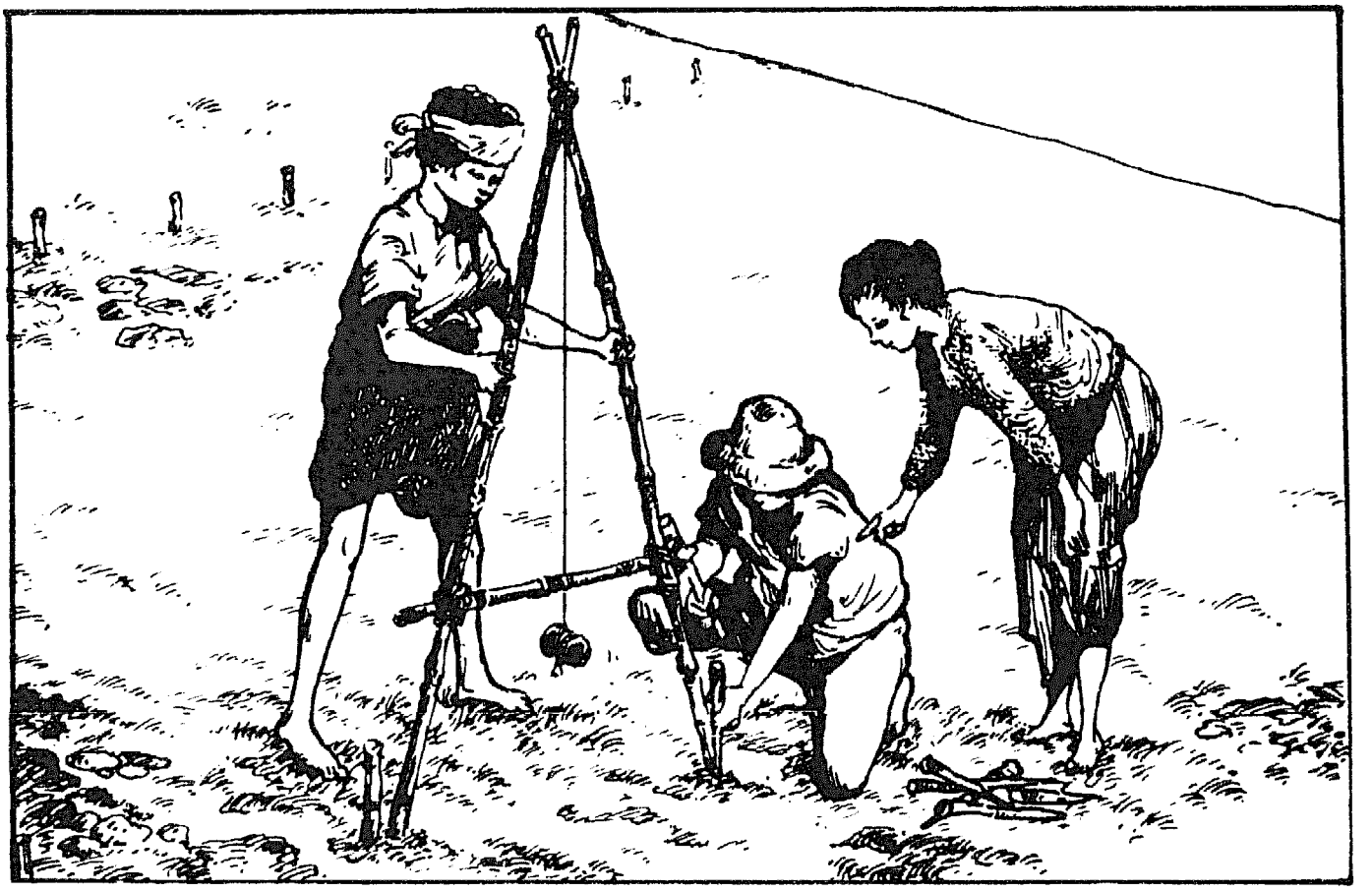
One common method of preventing the soil from washing away (or "eroding") is the use of physical barriers. These barriers often consist of wood (tree trunks or branches) or bamboo laid in lines along the hillside and held in place by stakes.



Farmers also use rock walls or certain kinds of plants to form barriers to slow erosion. The purpose of this practice is to divide the hillslope into smaller sections to reduce the force of the water flowing down the hill. While this practice works fairly well, it can still be improved upon.

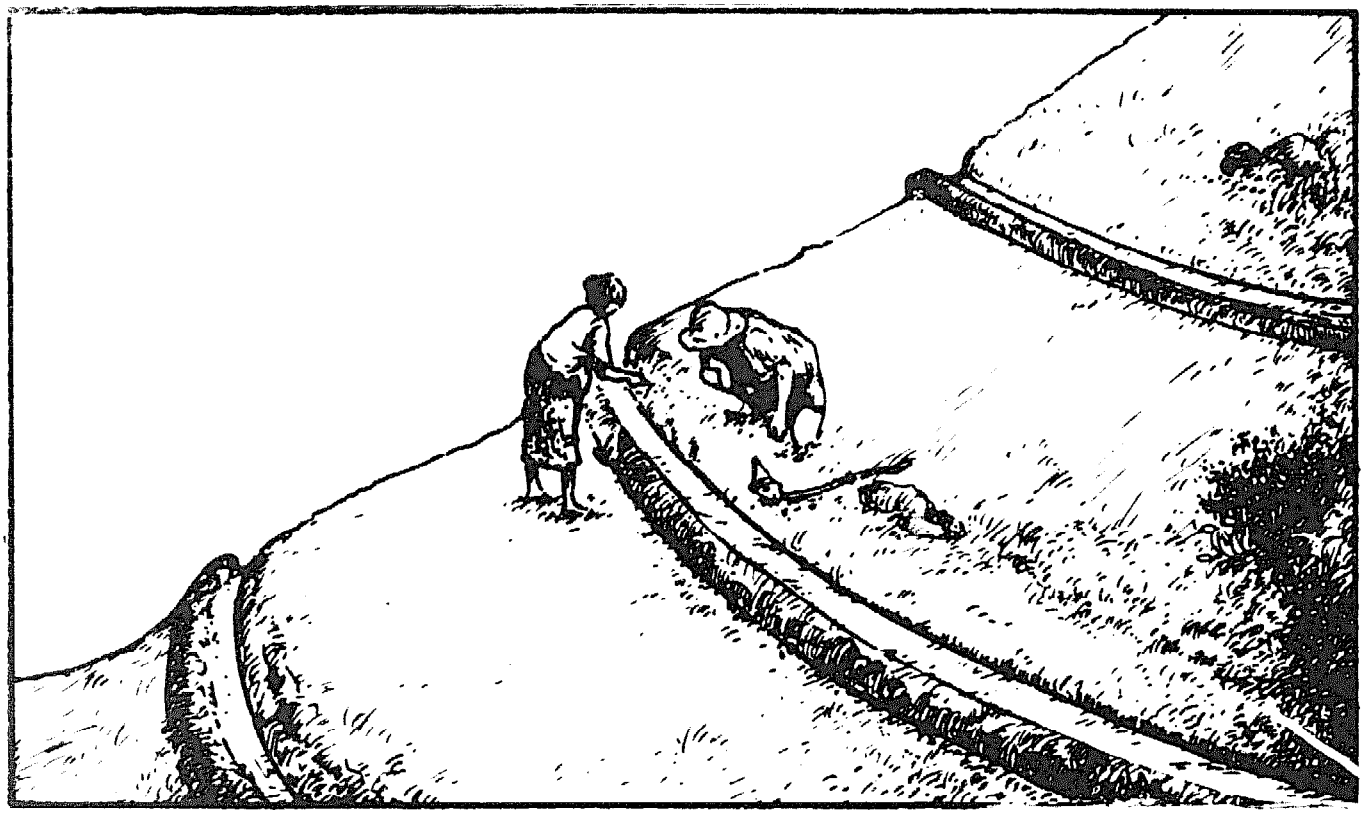


These practices can be improved by making sure that the barriers are placed along the contour. The "contour line" is an imaginary line which is the same level at all points along the slope.

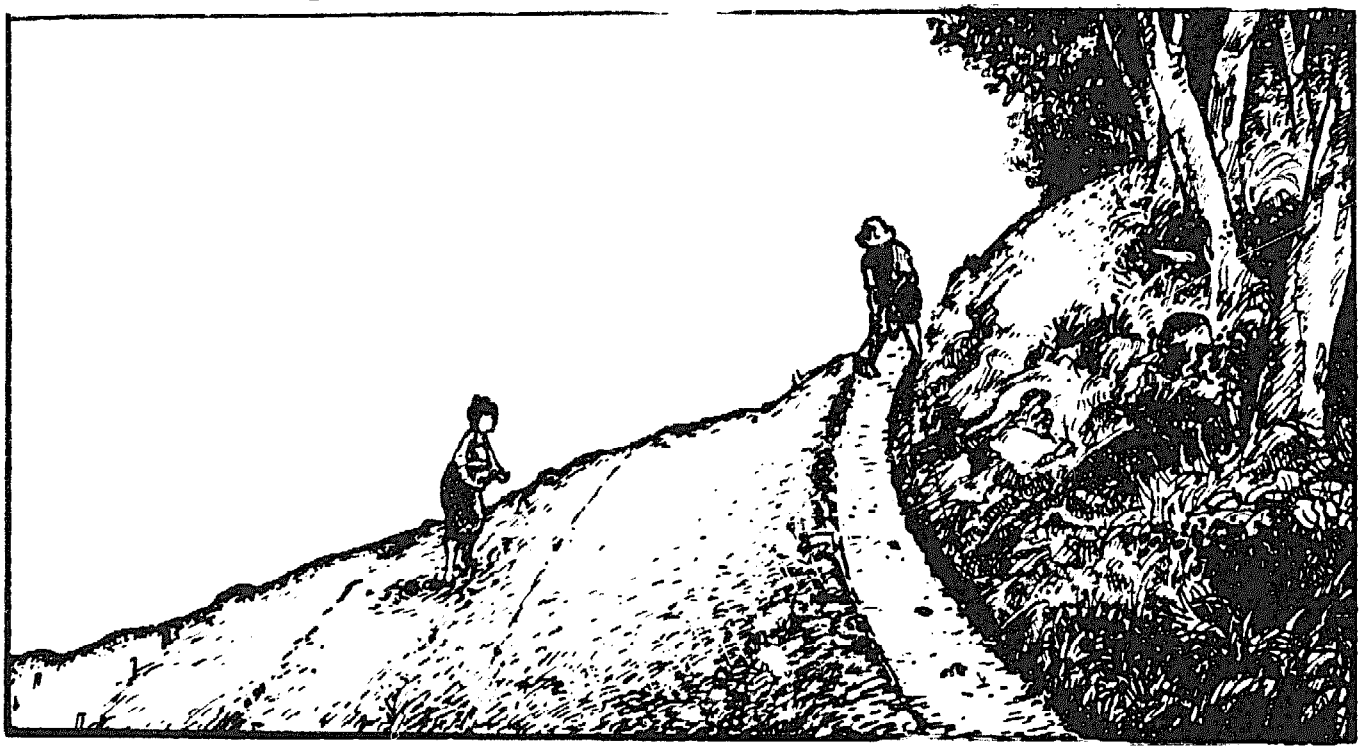


The contour lines can be determined by using an "A-Frame". The A-Frame is a simple tool that can be made from three pieces of wood or bamboo, some rope and a stone.

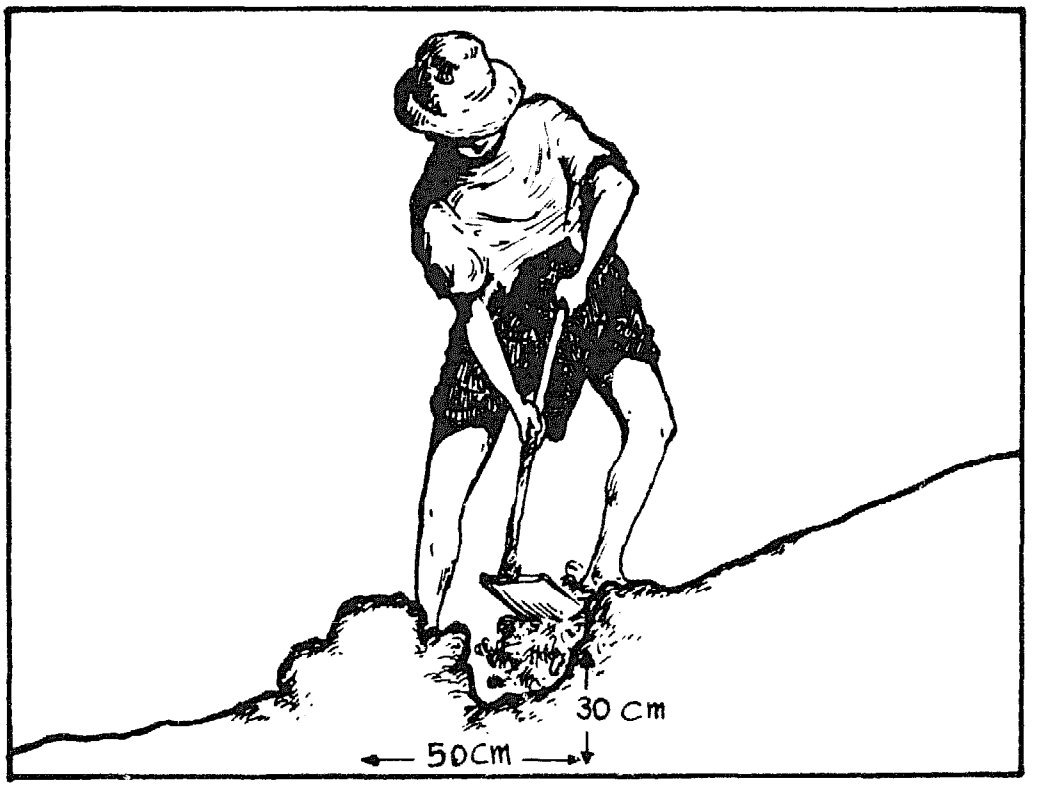
An agricultural extension agent, program field worker, or experienced farmer can demonstrate how to make and use an A-Frame in a short time. Once constructed and calibrated, the A-Frame is used to mark level contour lines along which the barriers will be placed.



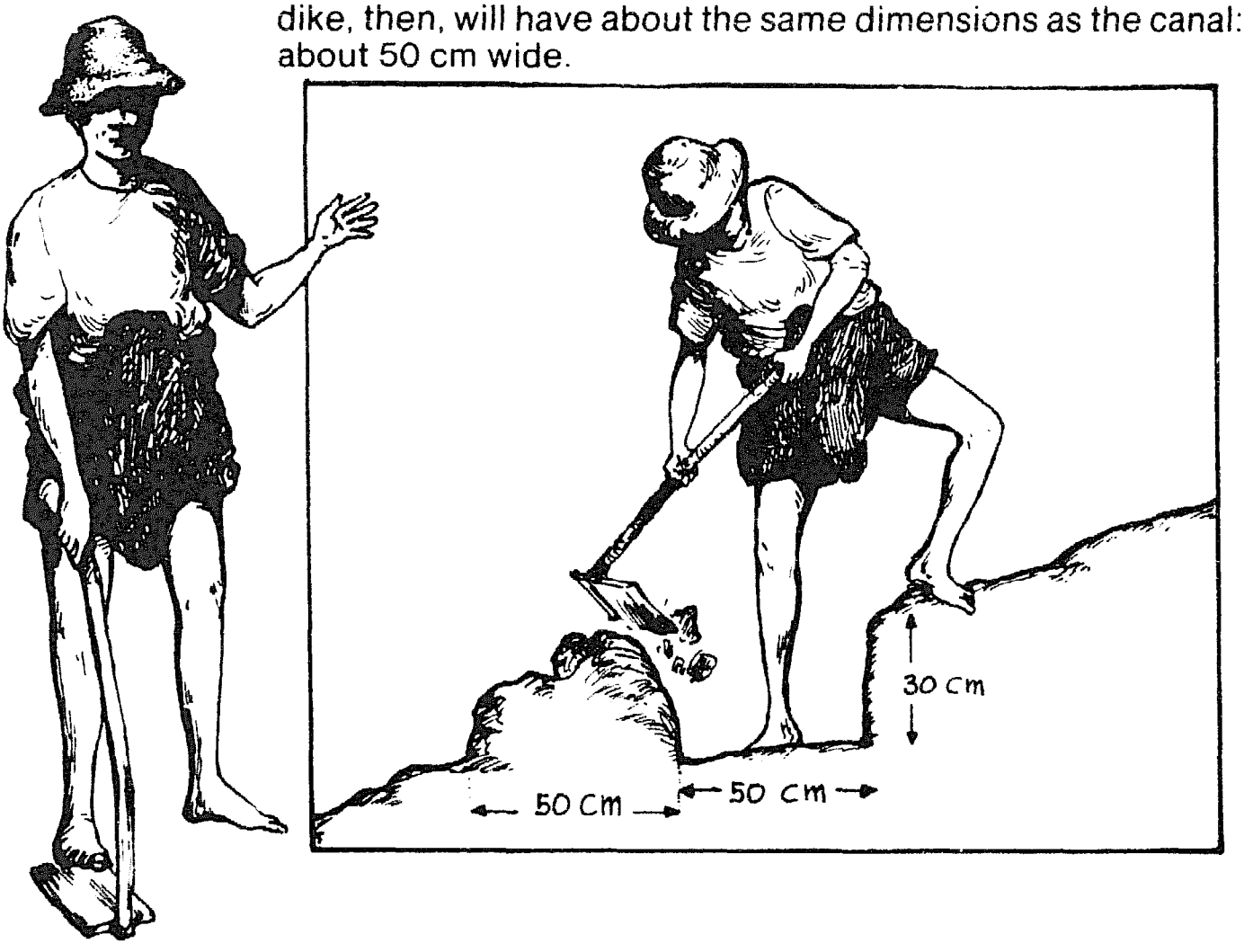
The shape of the barrier can also be improved upon. In fields with fairly deep soils, a ditch can be dug, forming a dike along the contour line. In addition to holding the soil, the purpose of this contour canal is also to reduce the flow of water so that more rainwater will be absorbed into the soil. Instead of running off (and carrying the soil with it), the absorbed water will keep the soil moist longer after the rains have stopped.



When marking contour lines and constructing contour canals or rock barriers, it is better to begin near the top of the farm. If work is begun at the bottom, the force of the water coming from above can destroy the work already completed.



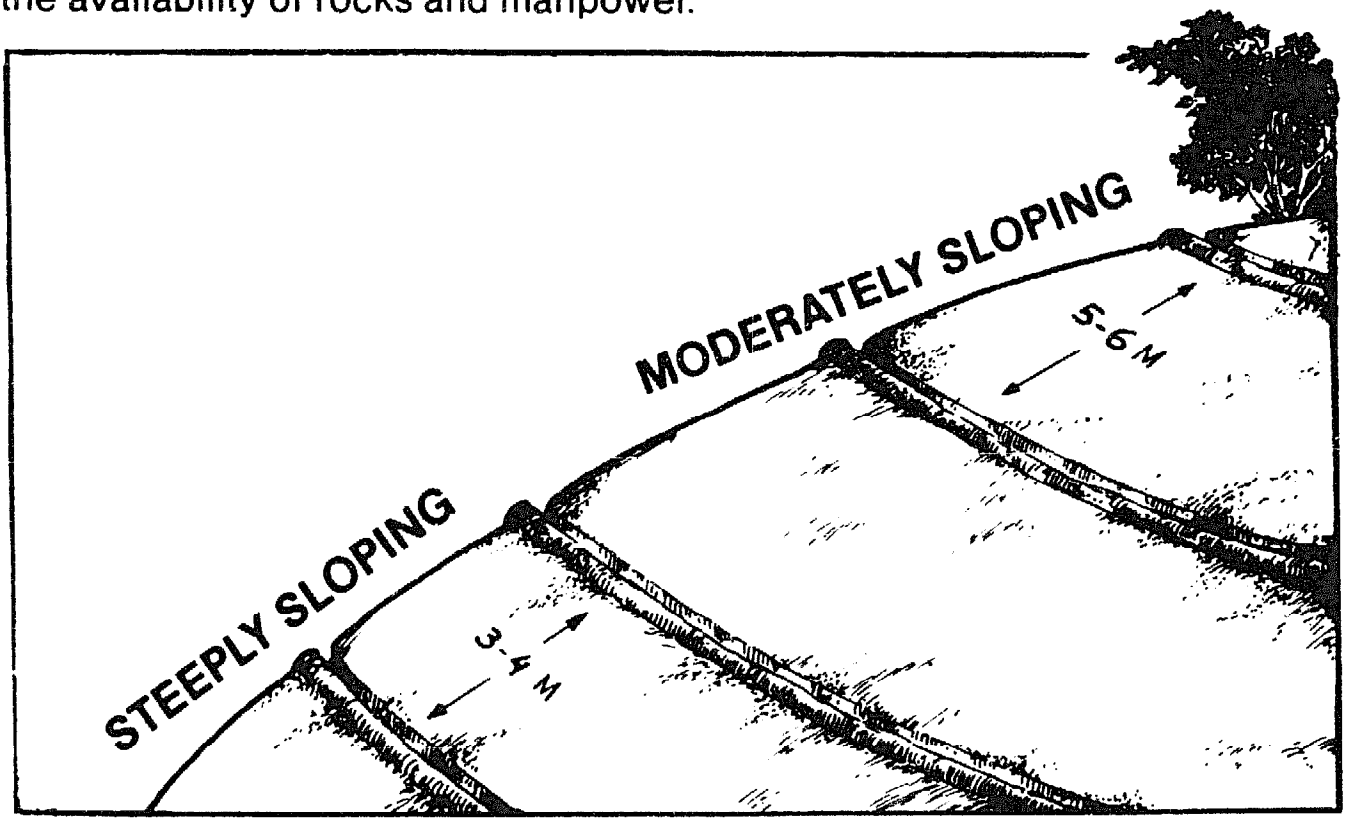
Construction of the contour canal and the dike is carried out at the same time. The canal is dug along the contour line to a depth of about 30 cm and with a width of about 50 cm. The dike, then, will have about the same dimensions as the canal: about 50 cm wide.



On thin or rocky soils, where contour canals are not possible, rock barriers can be an effective alternative. The rock wall should follow the contour line. This barrier can also slow the flow of water and reduce erosion.

The first step in constructing rock barriers is to make a level area about one-half meter wide along the entire contour line. This level area will become the foundation for the rock wall.

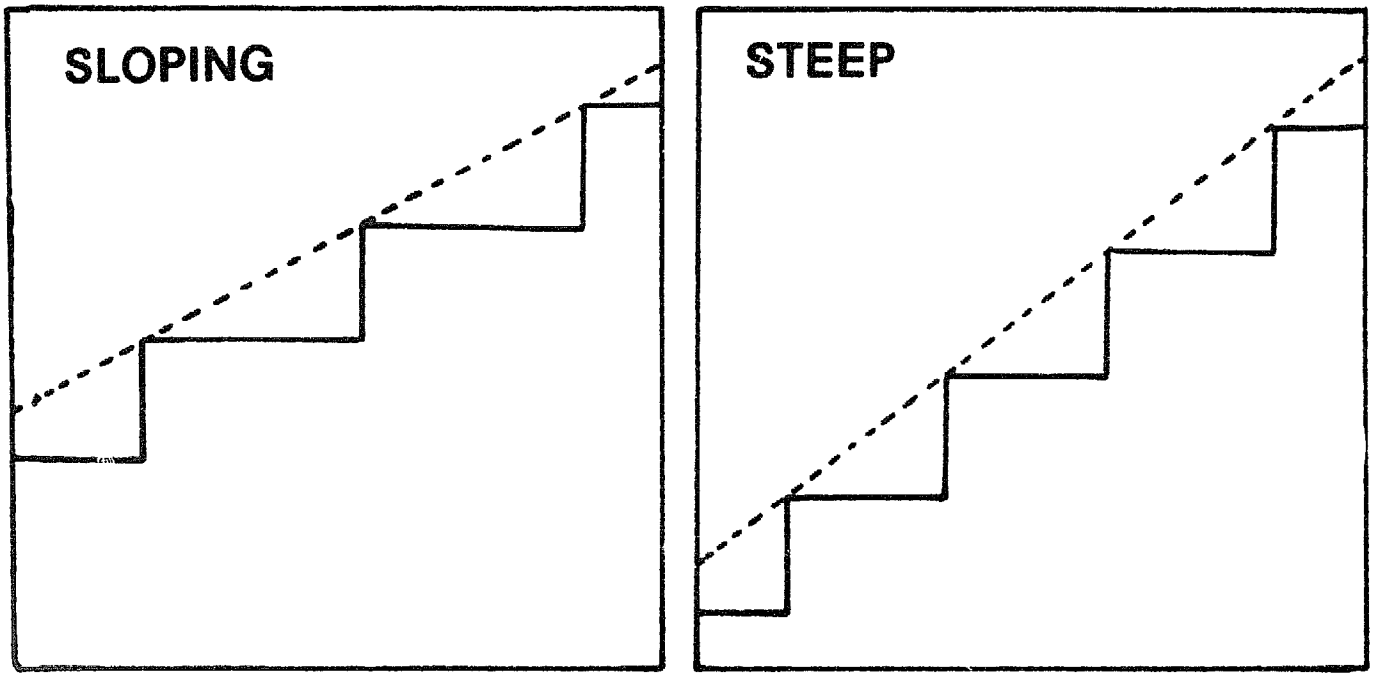
Larger rocks should be placed at the outer edges of the level area along the contour. Smaller rocks can then be placed between the two lines of larger rocks. The wall is built up in this manner until it reaches a height of one-half to one meter. The height of the wall will depend upon the slope of the hillside and the availability of rocks and manpower.



The distance between canals and dikes or rock walls is not always the same: it will depend upon the slope of the land and the objectives of the farmer. A general rule is to place lines 3 - 4 meters apart on steeply sloping land, and 5 - 6 meters apart on land that is moderately or slightly sloping.

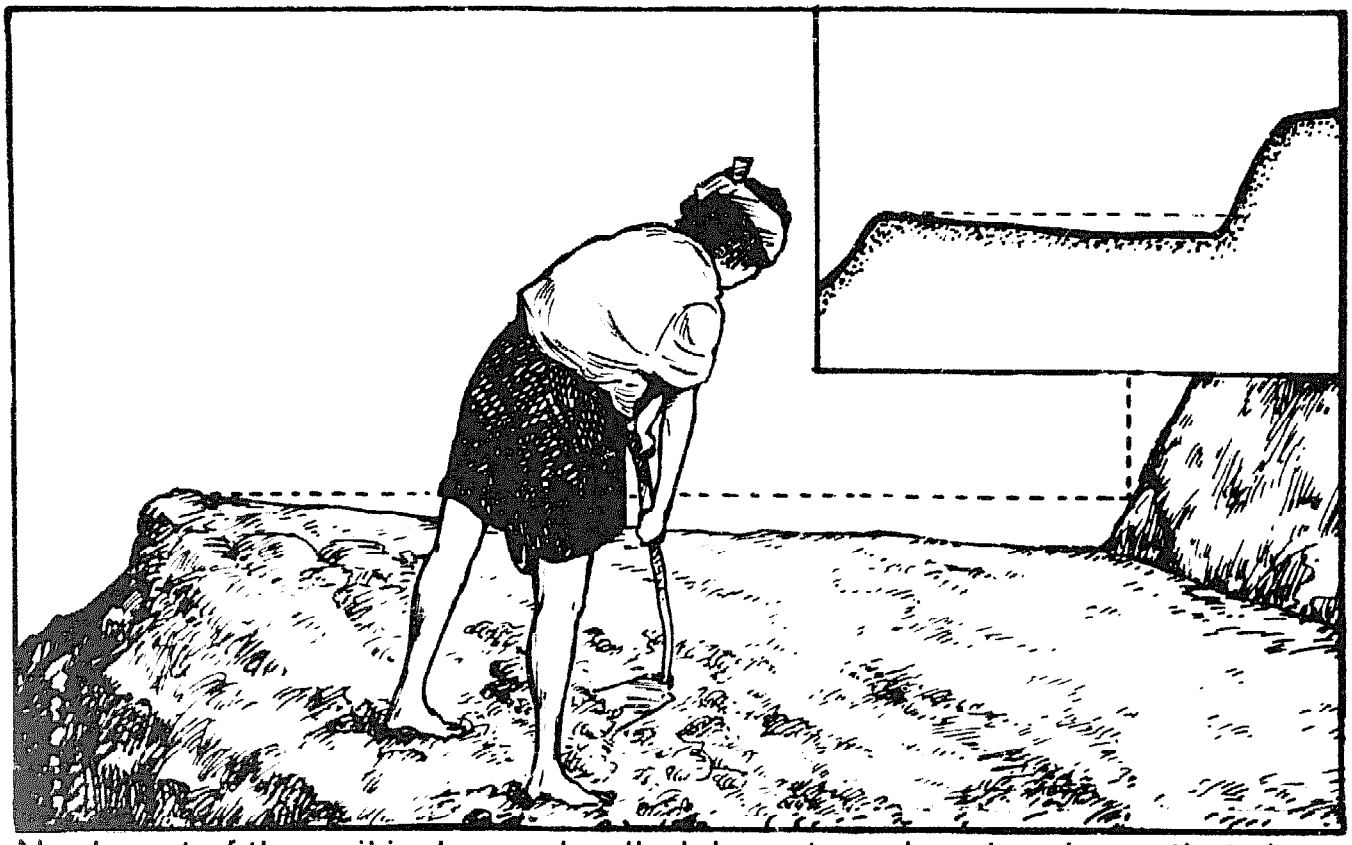
BENCH TERRACES

In addition to dikes and canals or rock walls, on fields with deep soils, "bench terraces" can be used to control erosion. Bench terraces show results faster, but require more time and energy to construct.

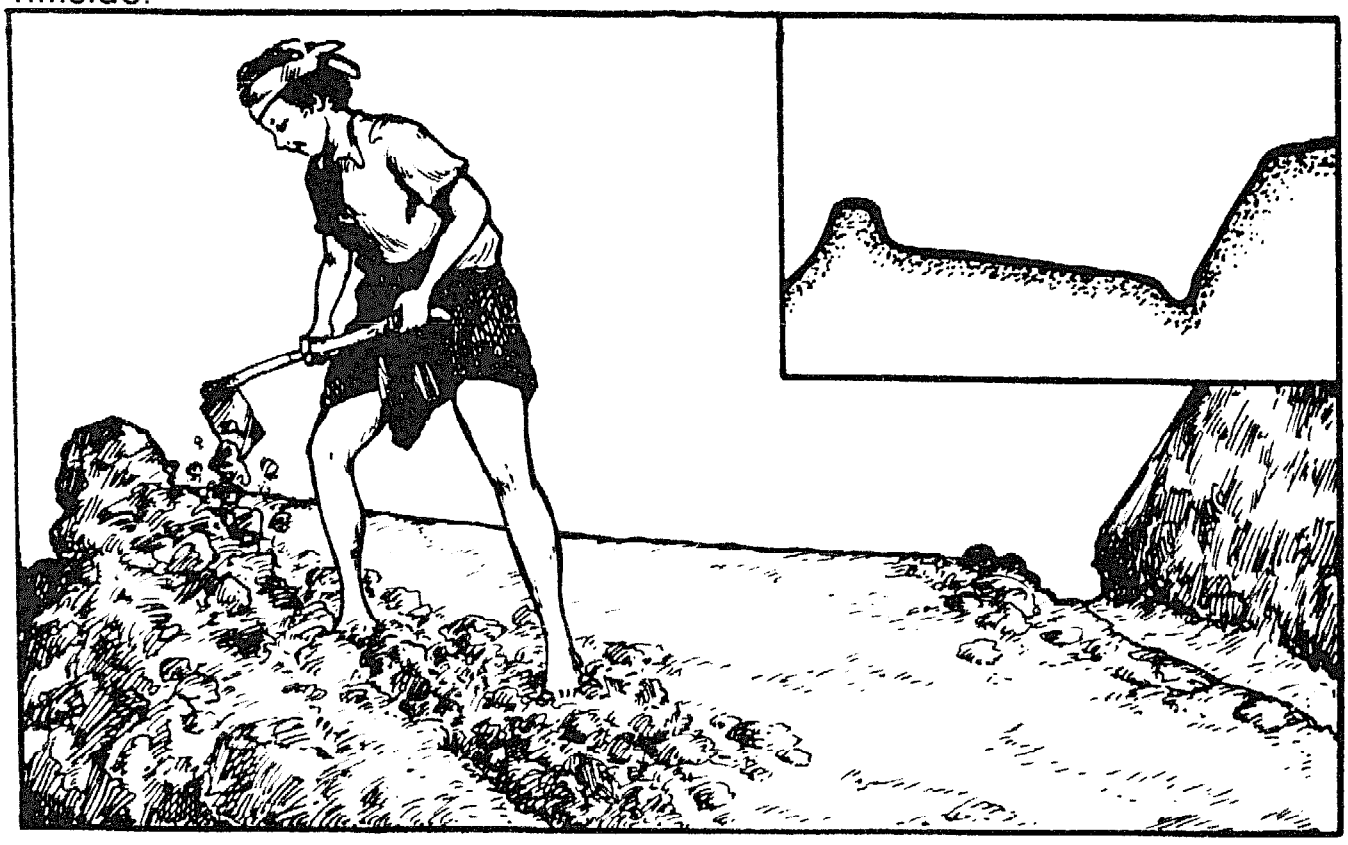


The first step in constructing bench terraces is to decide upon the size of the terraces and the distance between terraces. This will depend upon the slope of the land. On less sloping land, terraces should be larger. For steeper fields, the terraces need to be smaller. The size of bench terraces and distance between them also depends upon the farmers' needs and individual field conditions.

After fixing the size of the terraces and the distance between them, the terraces need to be dug. In order to ensure that the topsoil is not covered up later by the less fertile lower layer of soil, the fertile upper layer of soil should be moved to the side or below the area being leveled.

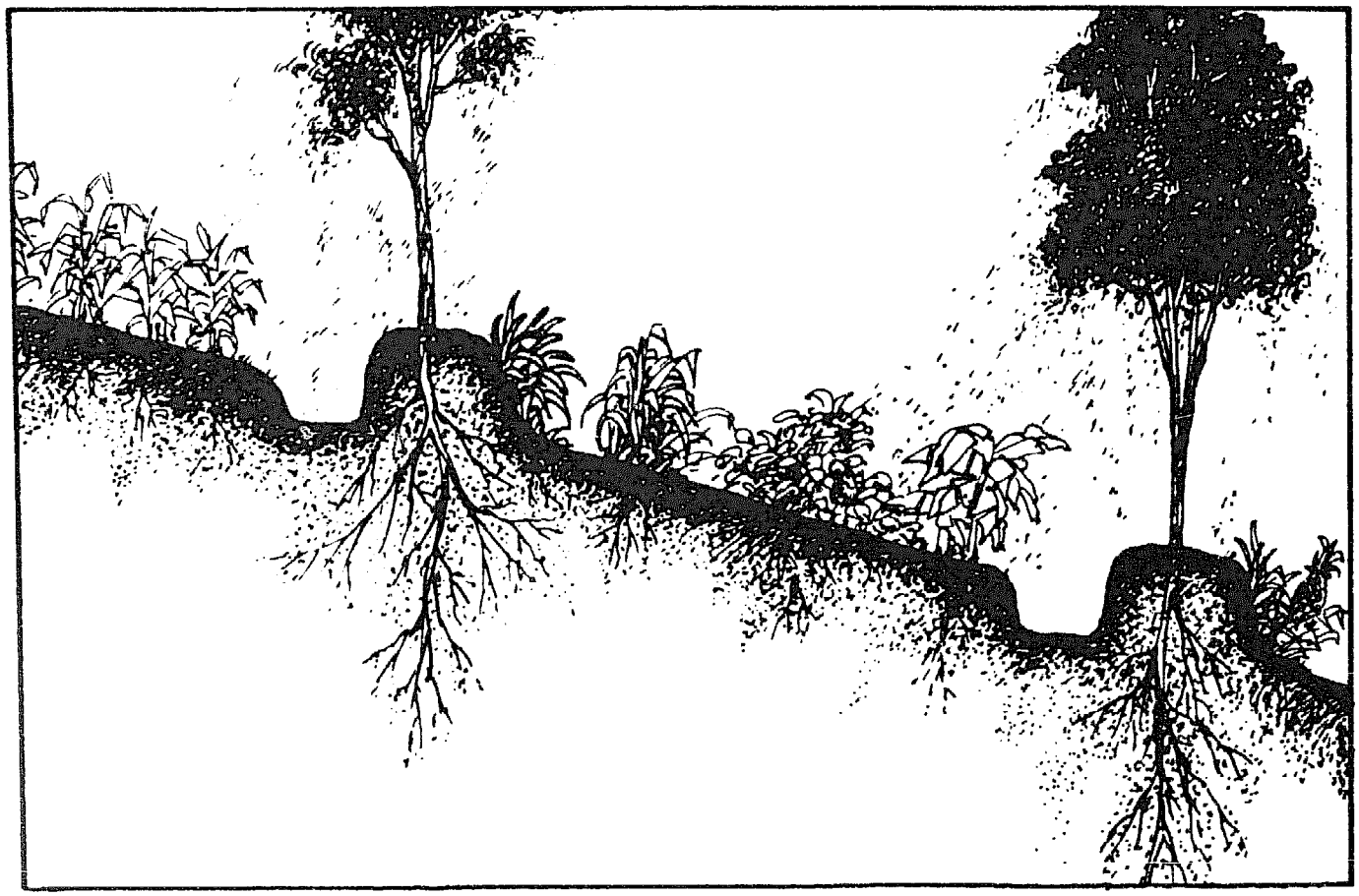


Next, part of the soil is dug and pulled down to make a level area that slopes downward slightly toward the hillside as shown above. The embankment should not be made too steep, but should also slope slightly toward the hillside.



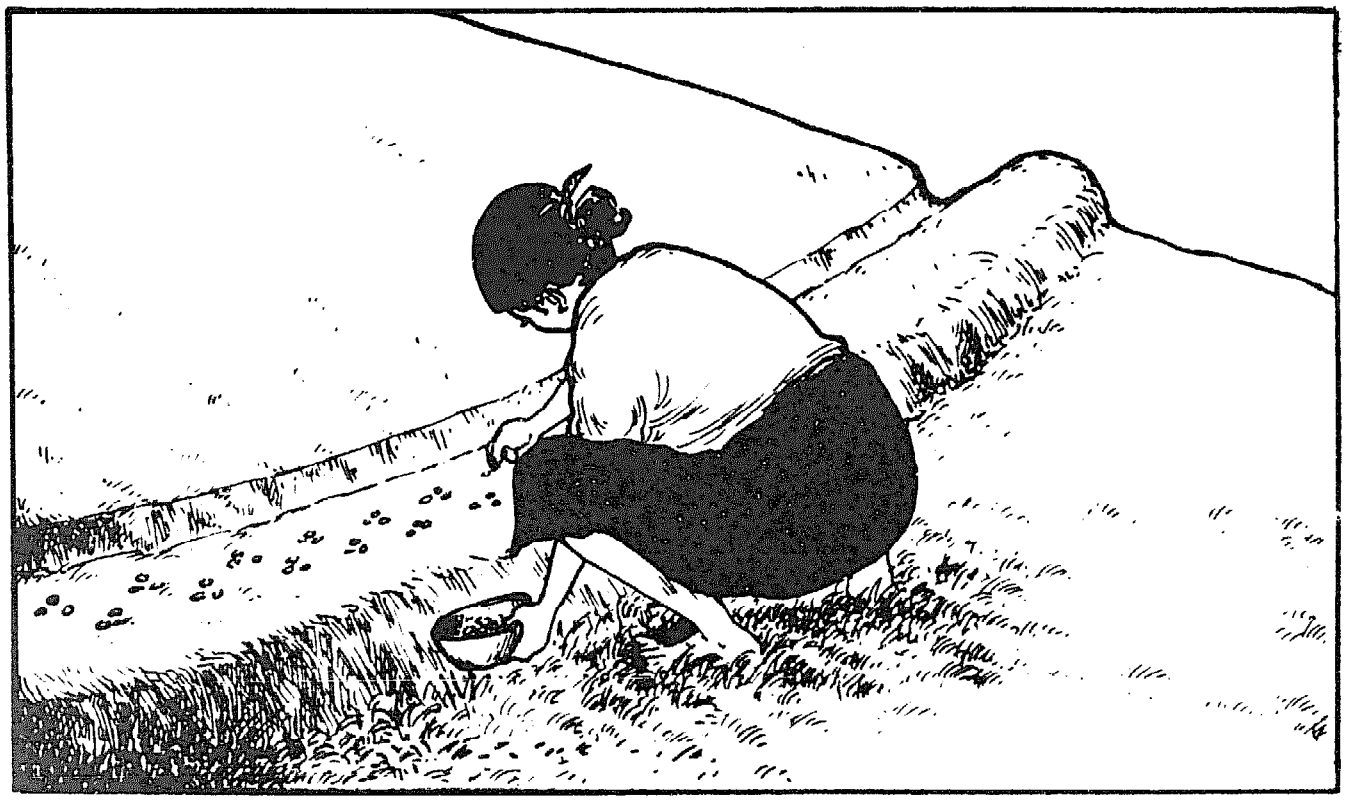
At the outer edge of the terrace, a dike or small ridge should be constructed, while a canal should be dug along the inner edge of the terrace to carry off the overflow of rainwater.

The last step to proper bench terrace construction is to return the fertile upper layer of soil (which was separated out in the early stages) to the level part of the terrace that will be planted.

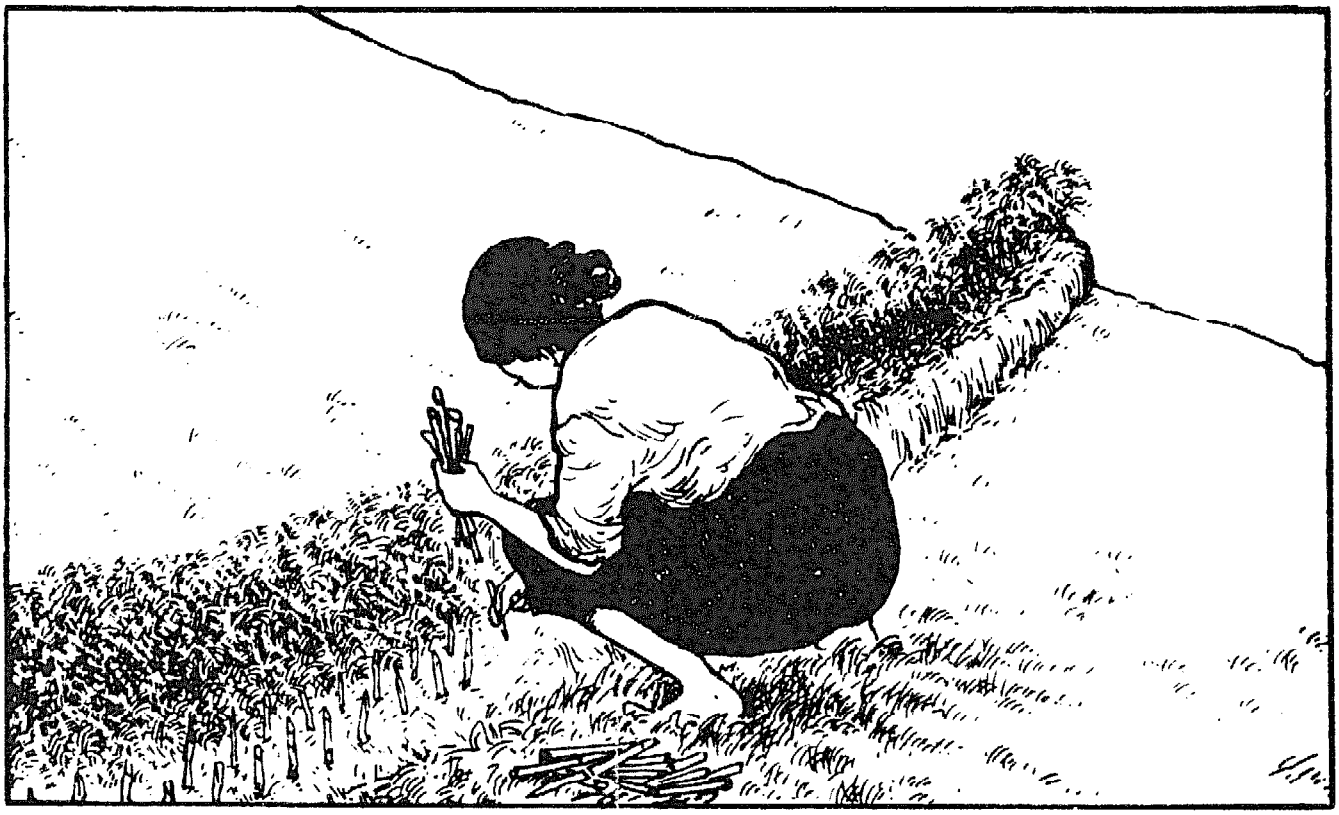


In addition to holding water and soil, another important aspect of "soil conservation" is maintaining soil fertility. Since there is no longer a forest cover to provide fertility, farmers themselves can plant trees or other plants that replace the role of the forest in providing important nutrients to the soil.

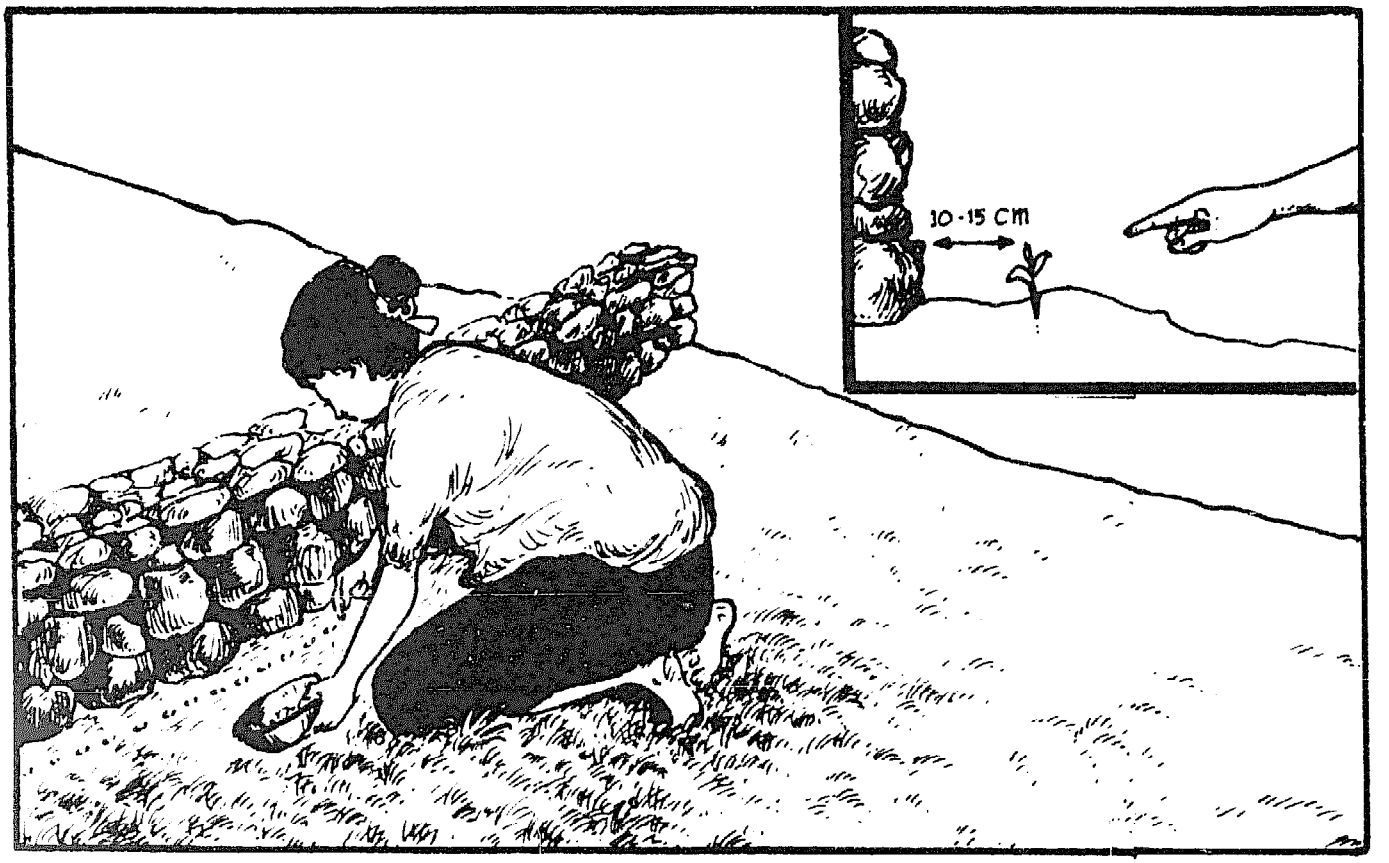
A variety of fast growing plants can be used to increase soil fertility, reduce erosion and slow the flow of water, and provide other benefits such as fuelwood and animal feed. Among the more commonly used species are calliandra, madre de cacao, leucaena, several kinds of grasses, and pineapples. While the trees and shrubs were chosen primarily because they improve soil fertility, grasses such as Napier grass and NB-21 (a Napier grass-pearl millet cross) and pineapples are used because their roots are effective soil barriers.



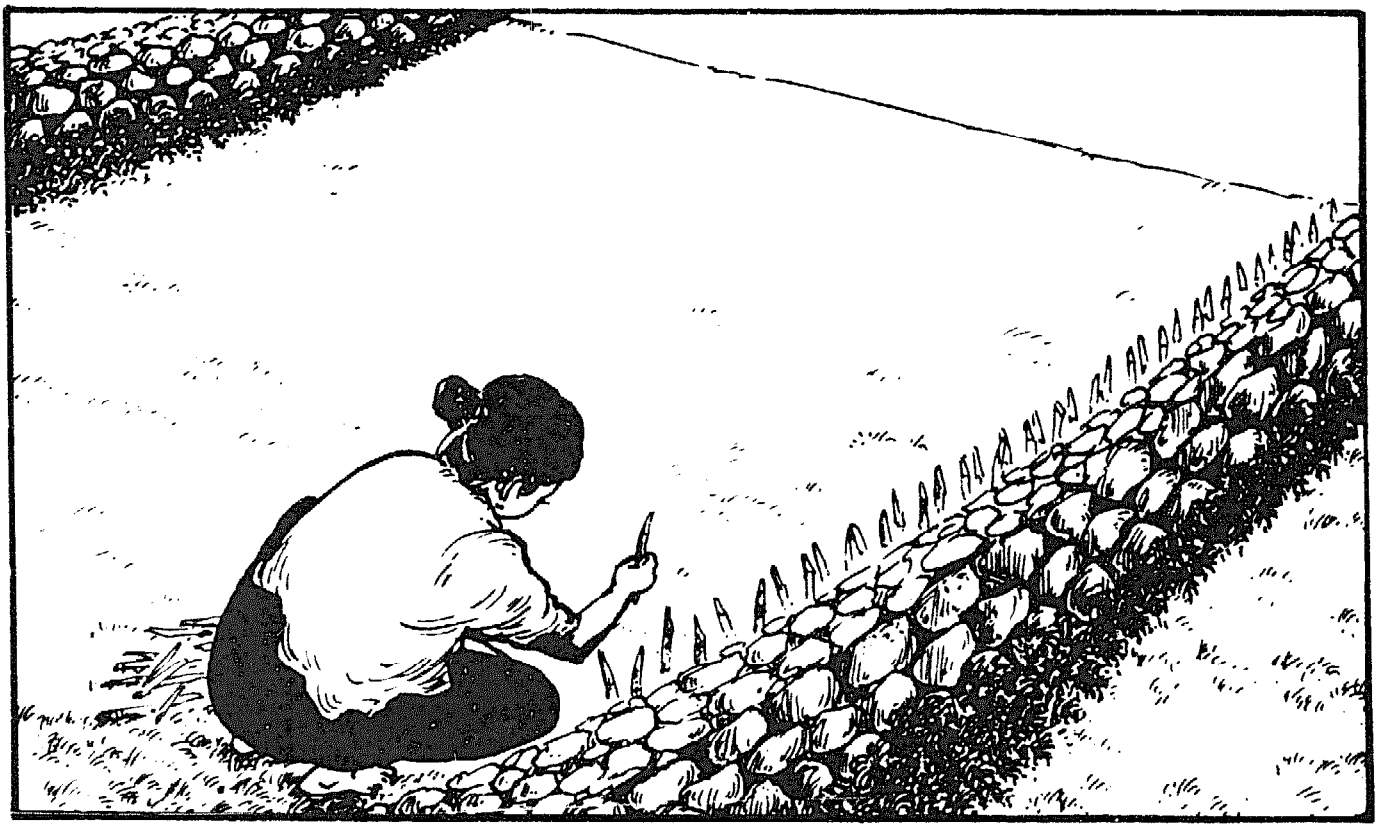
These plants can be used to strengthen the barriers that have already been constructed. If contour canals have been dug out, the trees can be planted along the length of the dike below the canal. The most popular planting method is to lay out two staggered lines of trees which are close together in order to form a strong and effective living barrier.



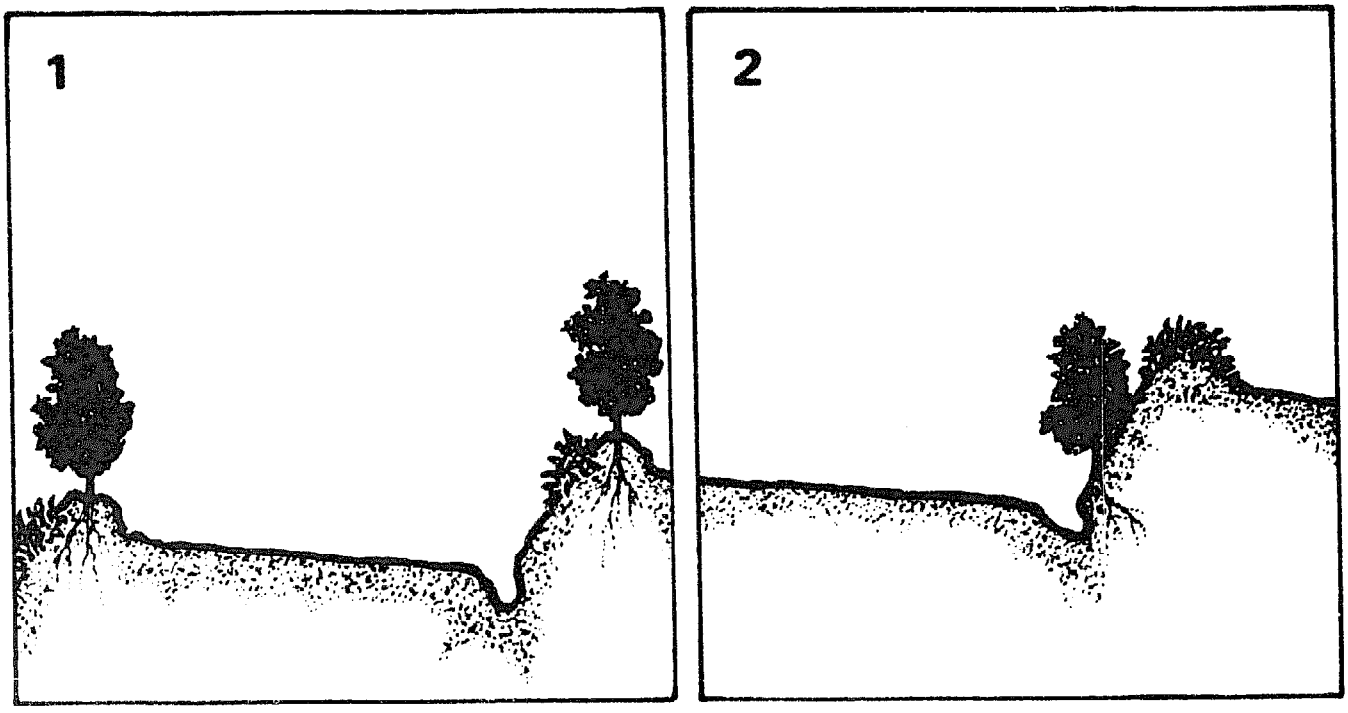
A variety of grasses or pineapples can be planted just below this line of trees to reinforce the barrier. These can be planted closely together in single or double rows.



If rock walls have been constructed, a slightly different method of planting should be used. Trees are planted at the base of the wall in a single line with a planting distance of not more than 10 cm between plants. The trees should be planted 10-15 cm from the edge of the wall.



The grasses or pineapples can then be planted along the upper edge of the rock wall.

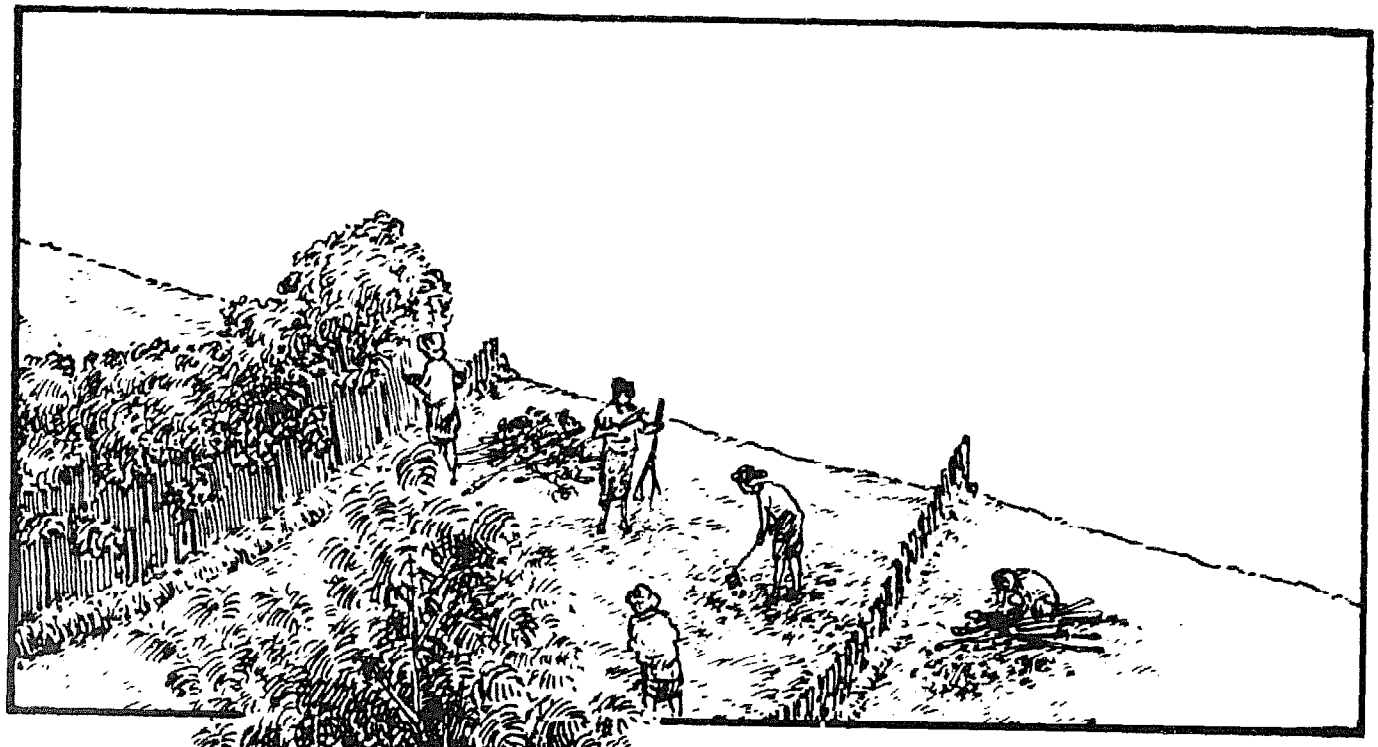


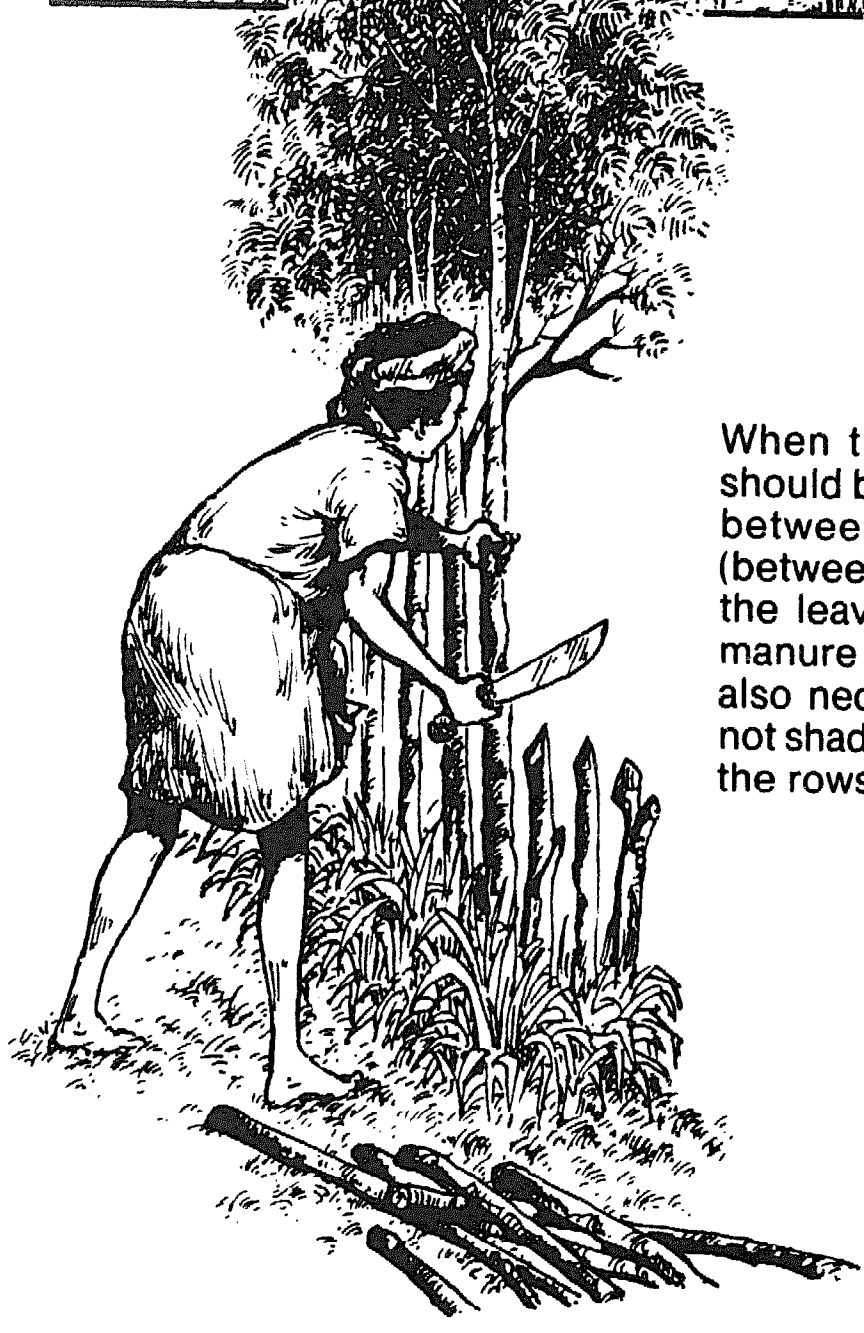
For bench terraces, two planting methods for living barriers can be used.

1) Trees are planted on the terrace dikes with grasses planted on the embankments below, or,
2) Trees are planted on the lower part of the embankment with grasses planted on the dikes.

Good maintenance is important for the above practices to be effective. For example, the contour canals must be cleaned from time to time, especially after heavy rains, when the ditches fill up with soil.

The young trees and/or grasses need to be properly cared for. They must be weeded and the soil around them loosened from time to time.



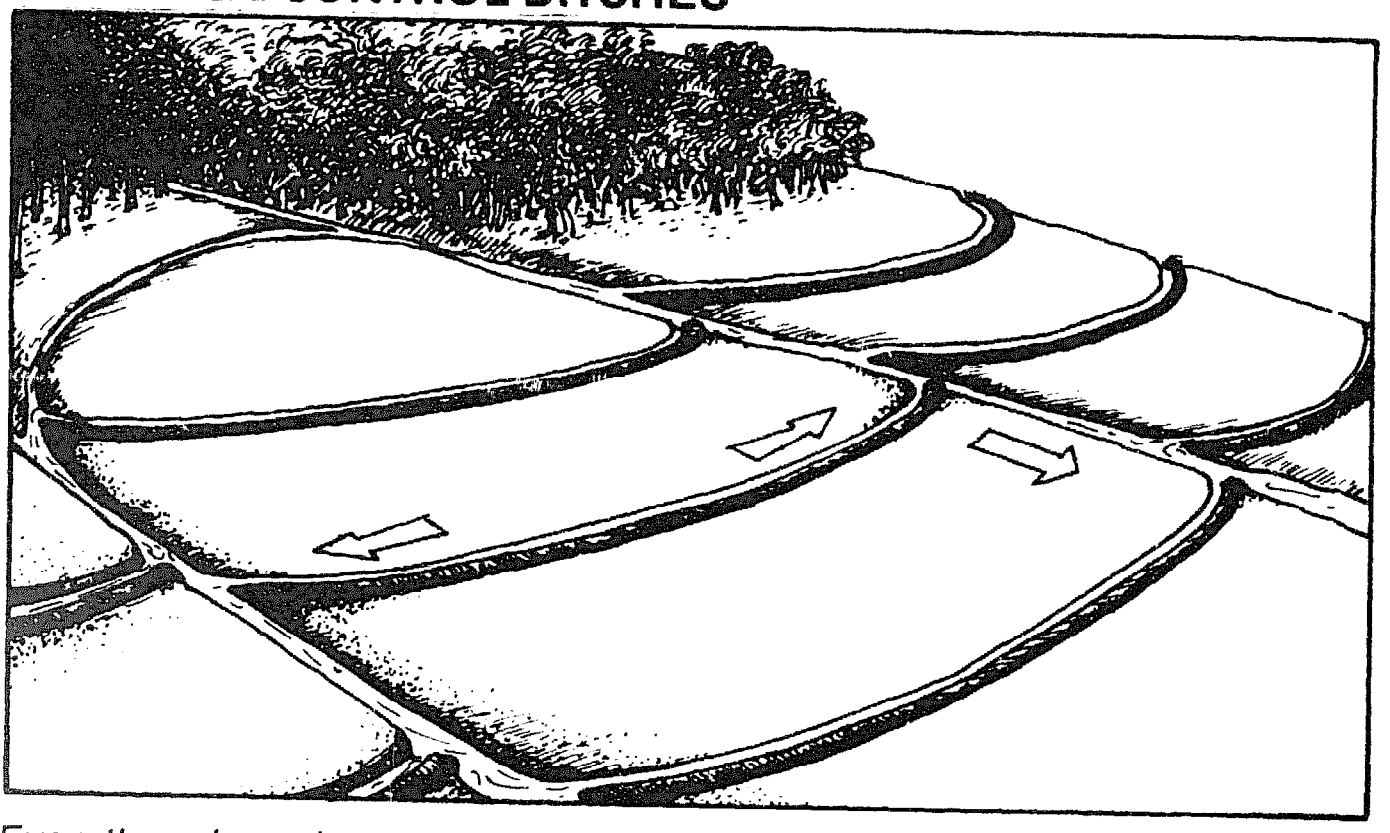


When the trees have grown, they should be pruned back to a height of between one half and one meter (between the knee and waist) so that the leaves can be used as a green manure to improve the soil. This is also necessary so that the trees do not shade the crops growing between the rows.

To use the leaves as "green manure" for improving soil fertility, they should be worked into the soil when it is cultivated for planting. This will also help the leaves decompose faster.

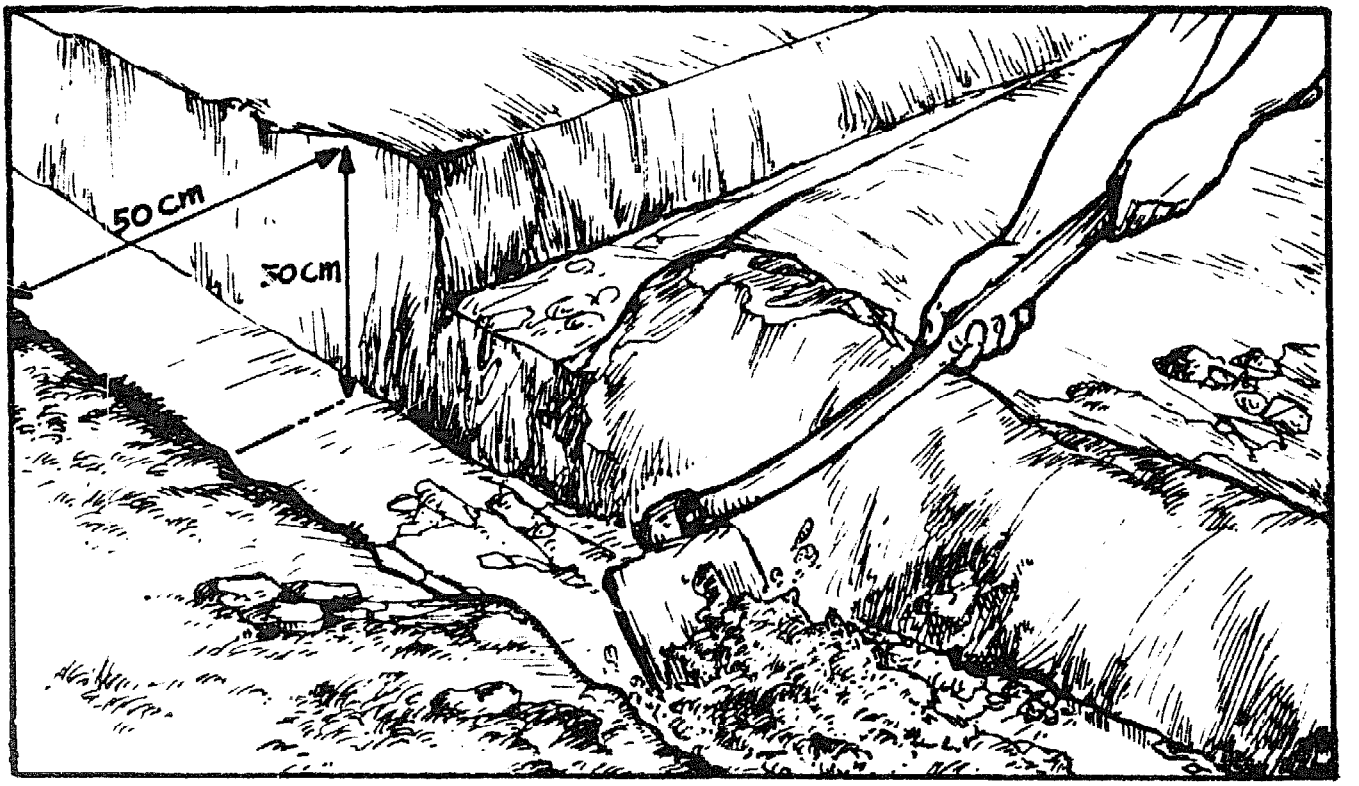
Grasses used along contour dikes or above rock walls should be cut close to the ground, to a height of about 2 - 3 cm (about the length of a thumb). Napier and NB-21 grasses provide excellent fodder, but should be cut back before they reach a height of a meter. Livestock do not like to eat taller grass because it is too coarse.

26 DRAINAGE CONTROL DITCHES

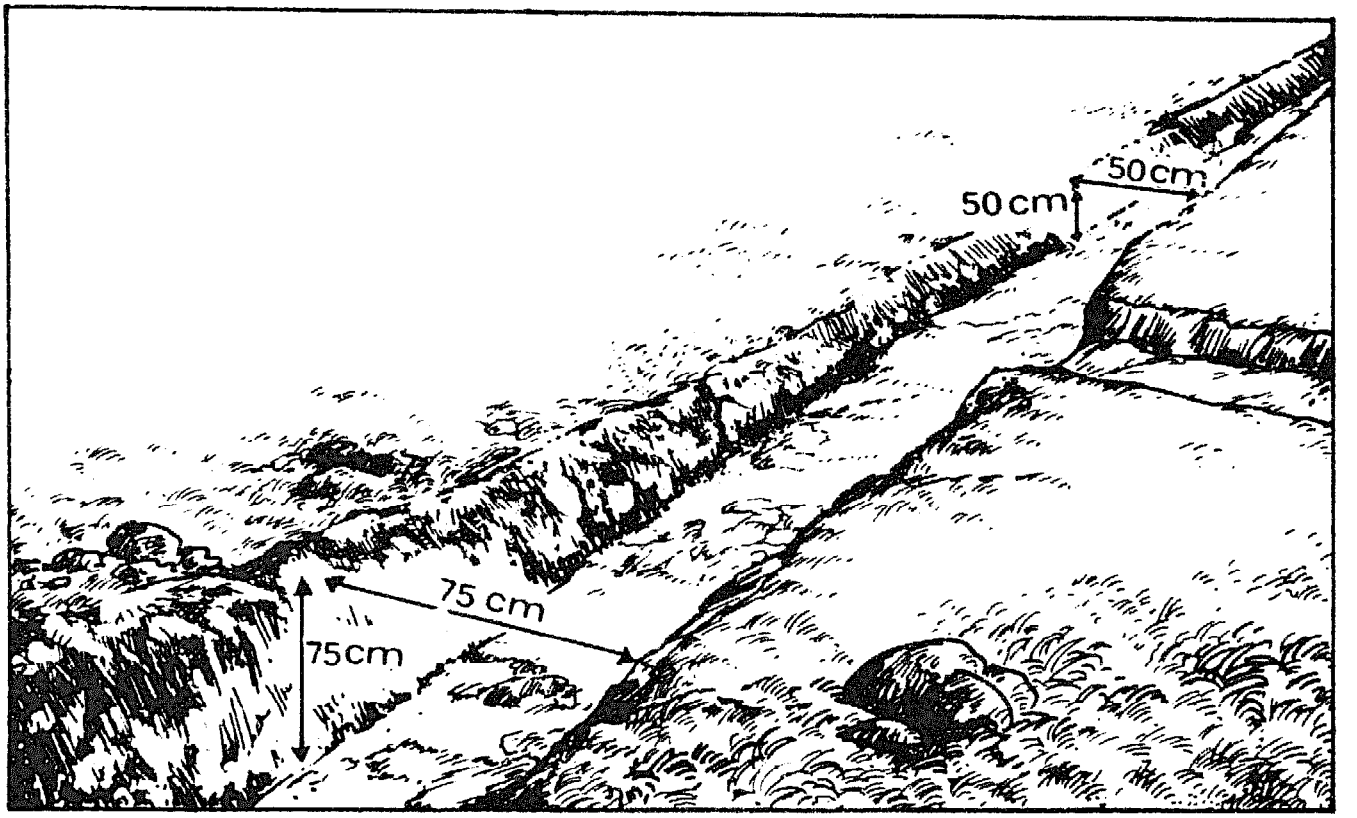


Even though contour canals, rock walls,and living hedgerow barriers have been constructed, there is still a danger of erosion from excess water from above. This water needs to be controlled so that it doesn't destroy the farm. A drainage control ditch should be dug to control the flow of water above and to the sides of the field.

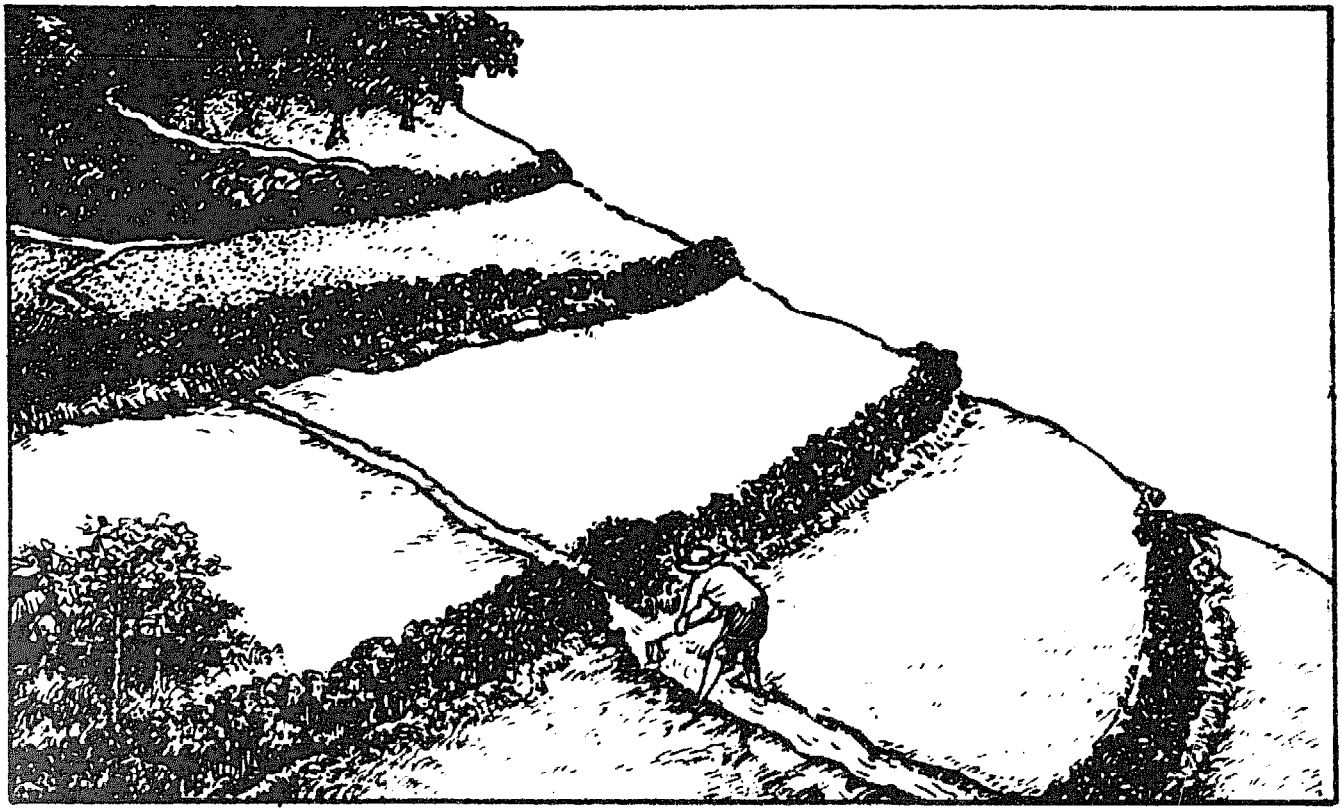
In some cases, such as fields with sandy soils or in areas at the bottom of the hill or in valleys, constructing the drainage control ditch should be the first step in protecting the farm.



In general, drainage control ditches should measure one half meter deep and wide. If there are contour canals, they should be connected to the drainage control ditches so that excess water can be drained off the field to prevent erosion.



The drainage control ditch at the lower end of the field should be deeper and wider than at the upper end so that the accumulating water doesn't overflow near the bottom.



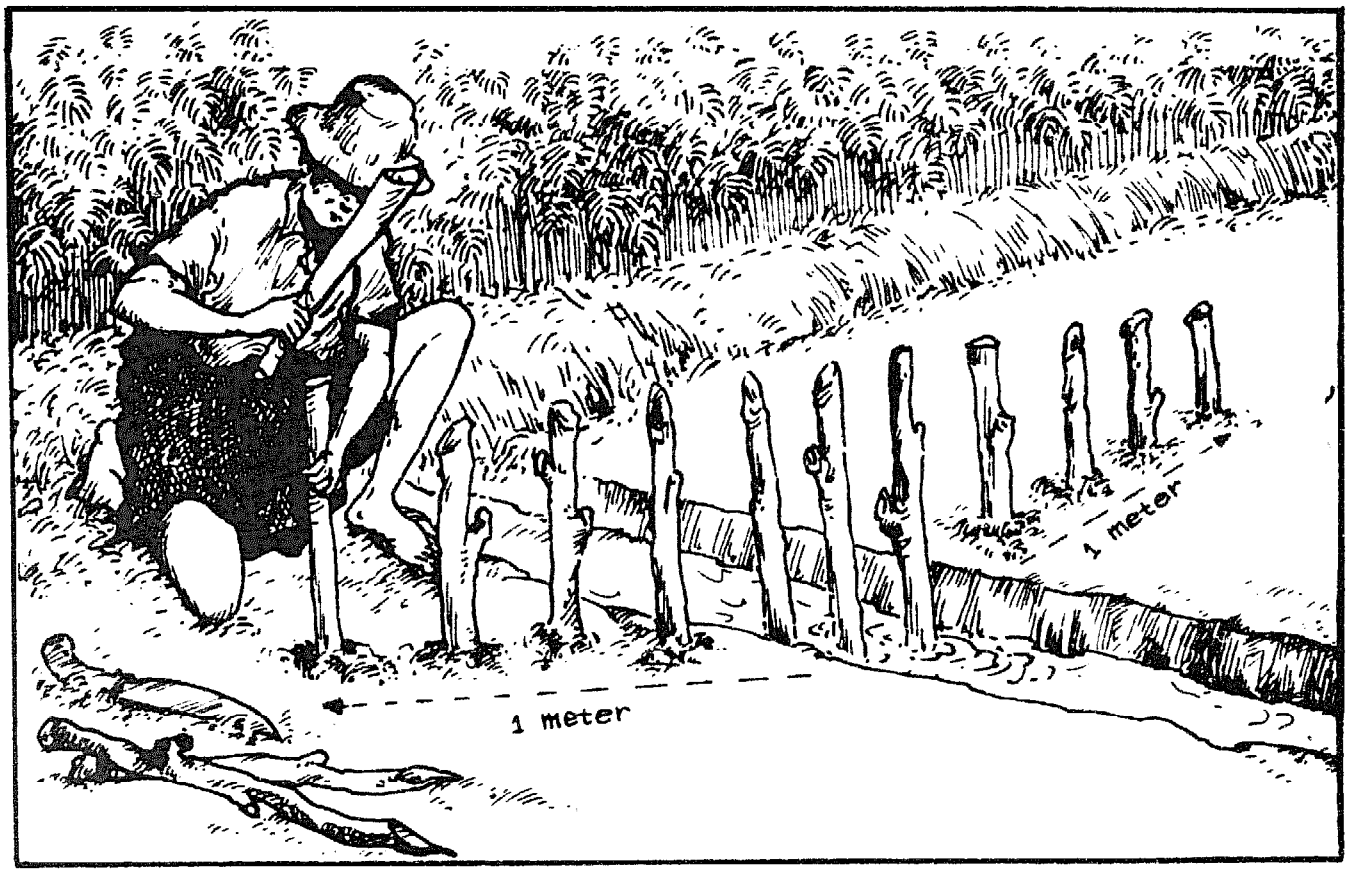
Gullies or small streams that have formed naturally at the edges of the farm can also be used as drainage control ditches. These can be connected to the ditch dug at the upper section of the field, and also to the contour canals.

Plants can be planted on both sides of the drainage control ditch to help slow the flow of water and maintain the shape of the ditch.

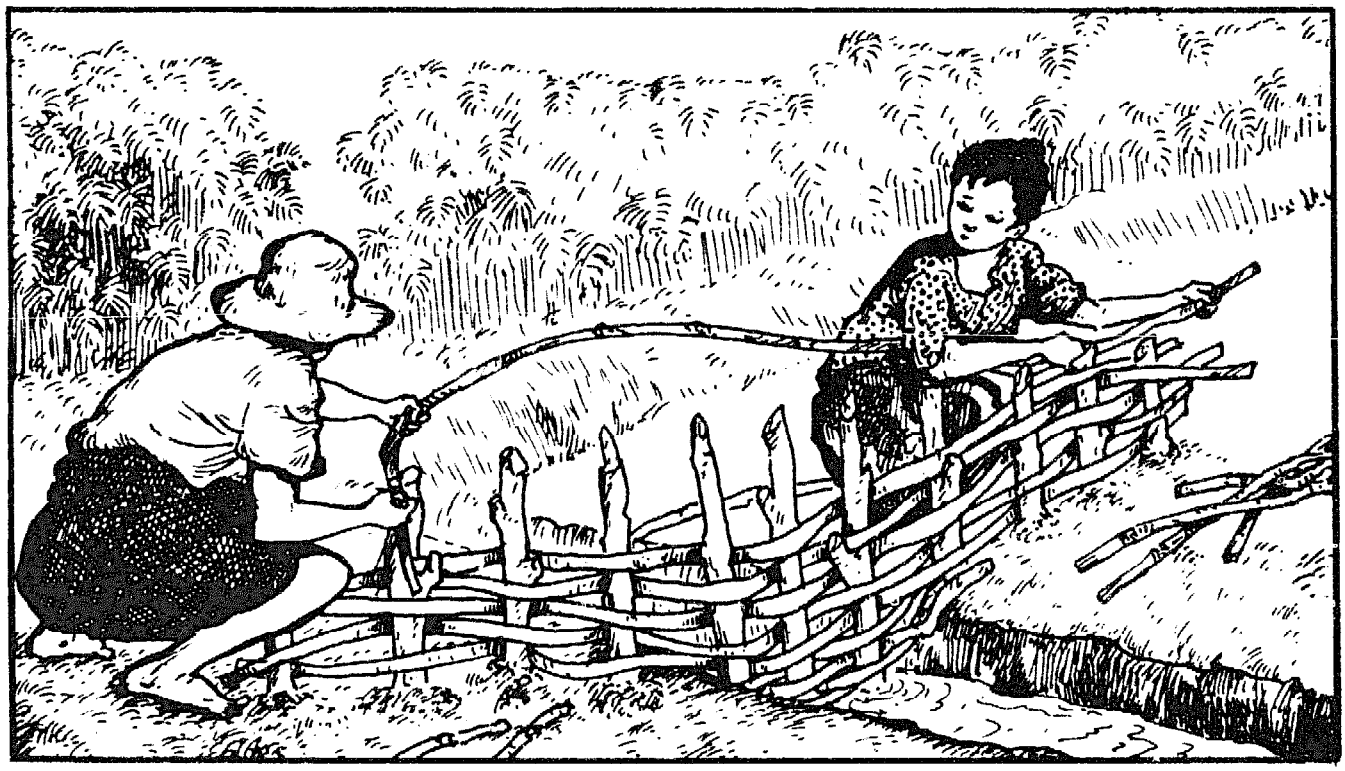
CHECK DAMS and SOIL TRAPS

Water flowing in drainage control ditches or in natural watercourses such as gullies can build up great speed and force. To slow down the flow of water in the drainage ditch and protect it from becoming too deep, "check dams" and/or "soil traps" can be constructed. These structures will help ensure as much water as possible is absorbed into the soil as well as reduce erosion.

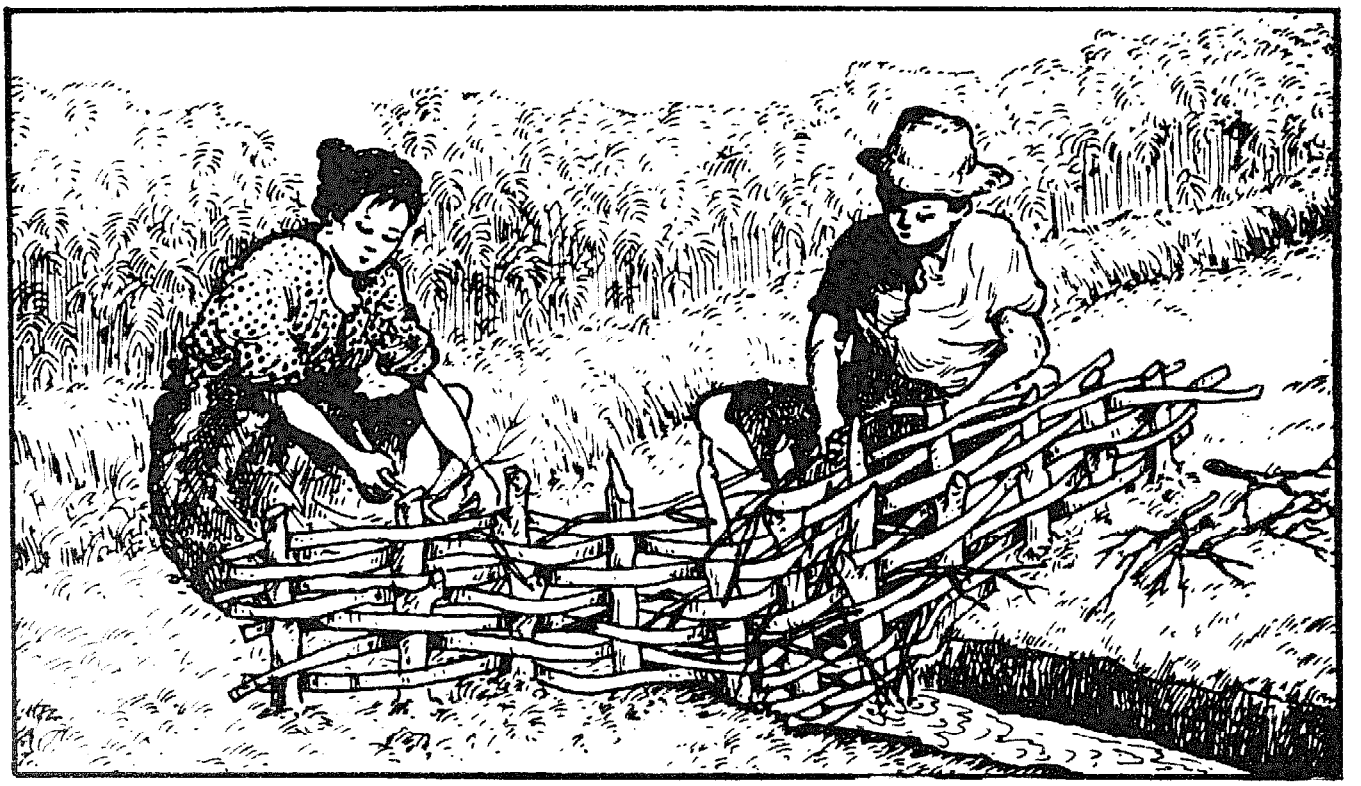
Check dams are small, simple structures that farmers can construct and maintain themselves. They are used to prevent gully erosion and to slow down water flow in the drainage system. The first step in check dam construction is to mark a straight line across the gully or ditch. This should follow the contour line across the slope.



Next, stout pegs or stakes should be driven into the ground along the line including a distance one meter outside the gully on both sides. If possible, plants that can be grown from cuttings should be used. These cuttings or stakes will grow and form a living barrier.

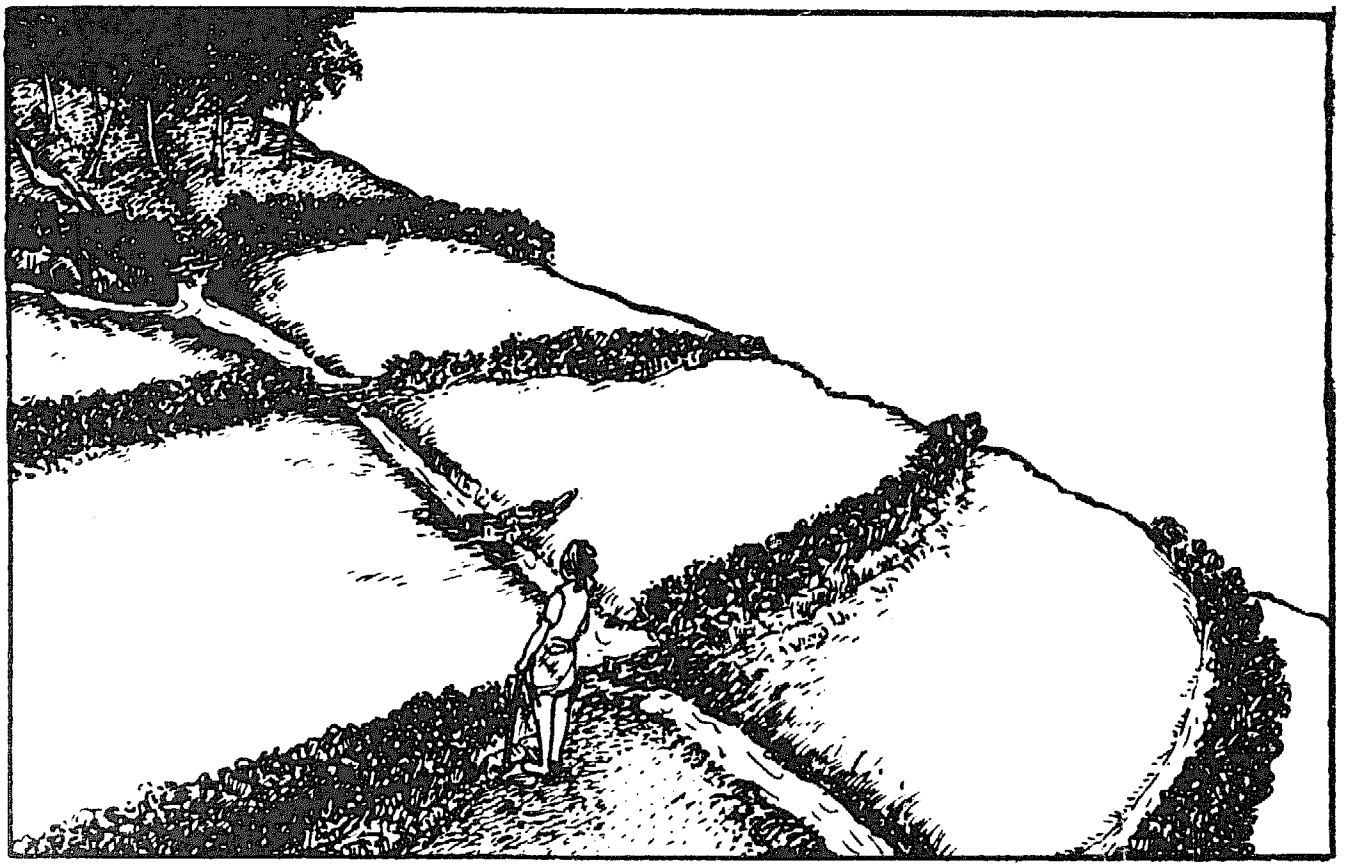


Bamboo or branches should then be woven between the stakes to help hold these in place. This will also make the barrier stronger and thicker. Rocks can be placed on the upper side of the structure.



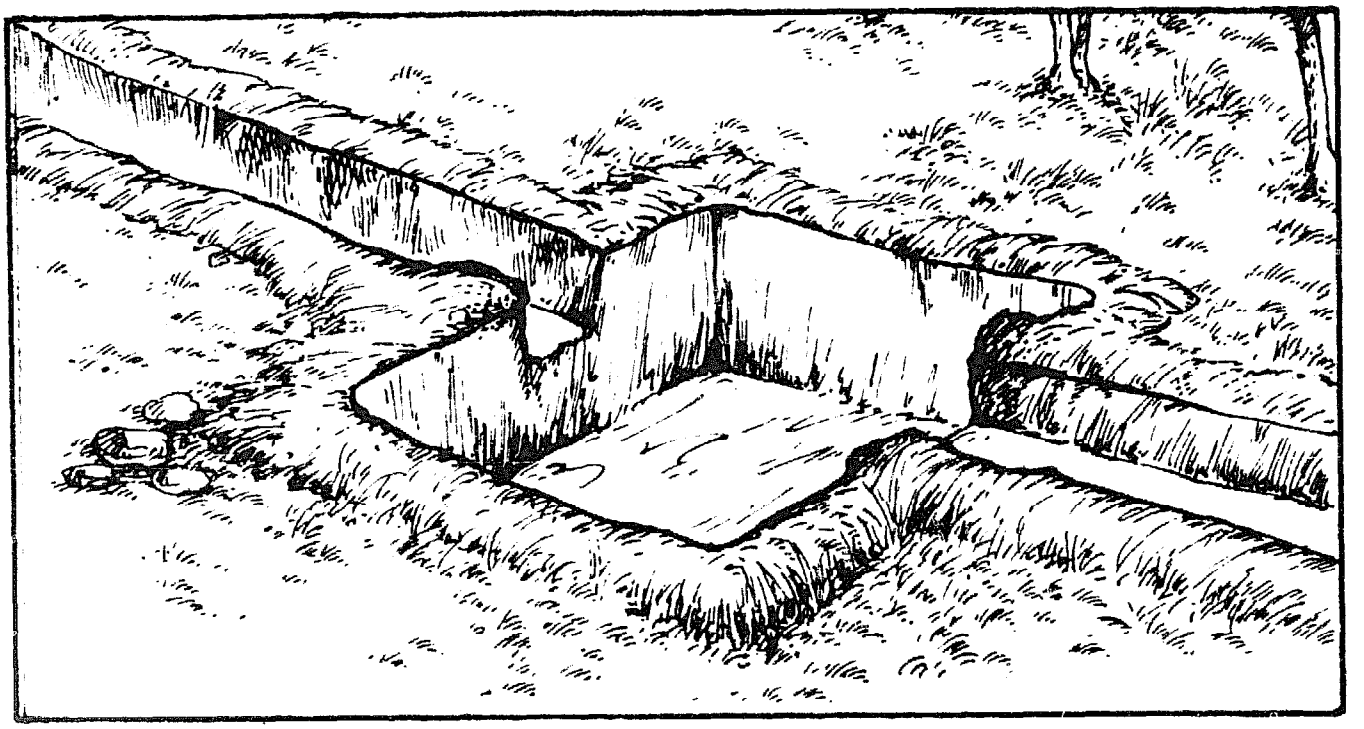
After the bamboo or branches are woven in between the stakes, brush or other material can be placed against the dam's upper side. Water passing through the structure will be slowed down, allowing its load of soil to be deposited behind the dam.

It is important to begin constructing check dams at the top of the gully (the area furthest up the hill). If the check dams are built at the bottom first, the water collected above may be strong enough to break the dams below.

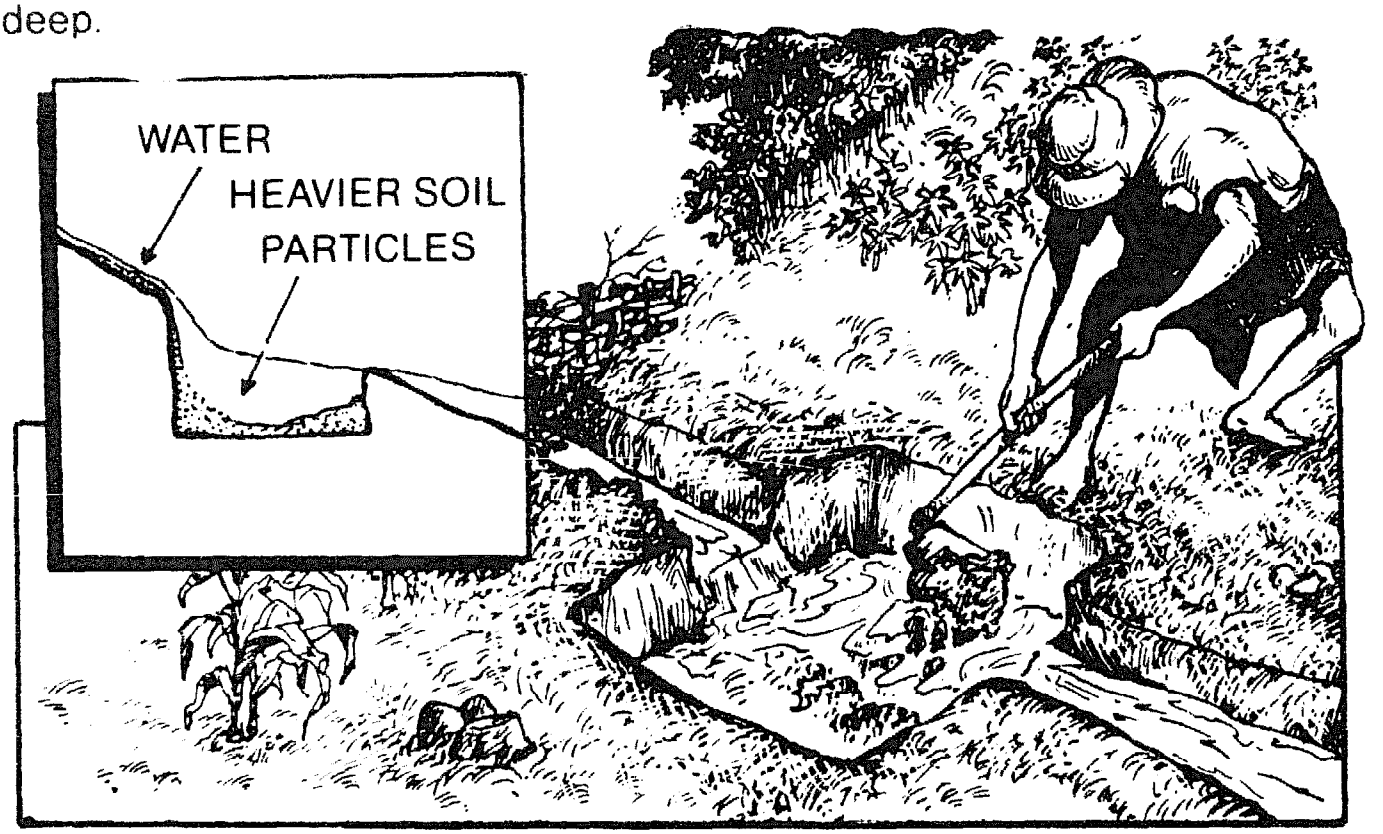


The distance between check dams will vary. The steeper the slope, the closer together they should be placed. With experience, farmers can judge the best distance between dams for their individual farms.

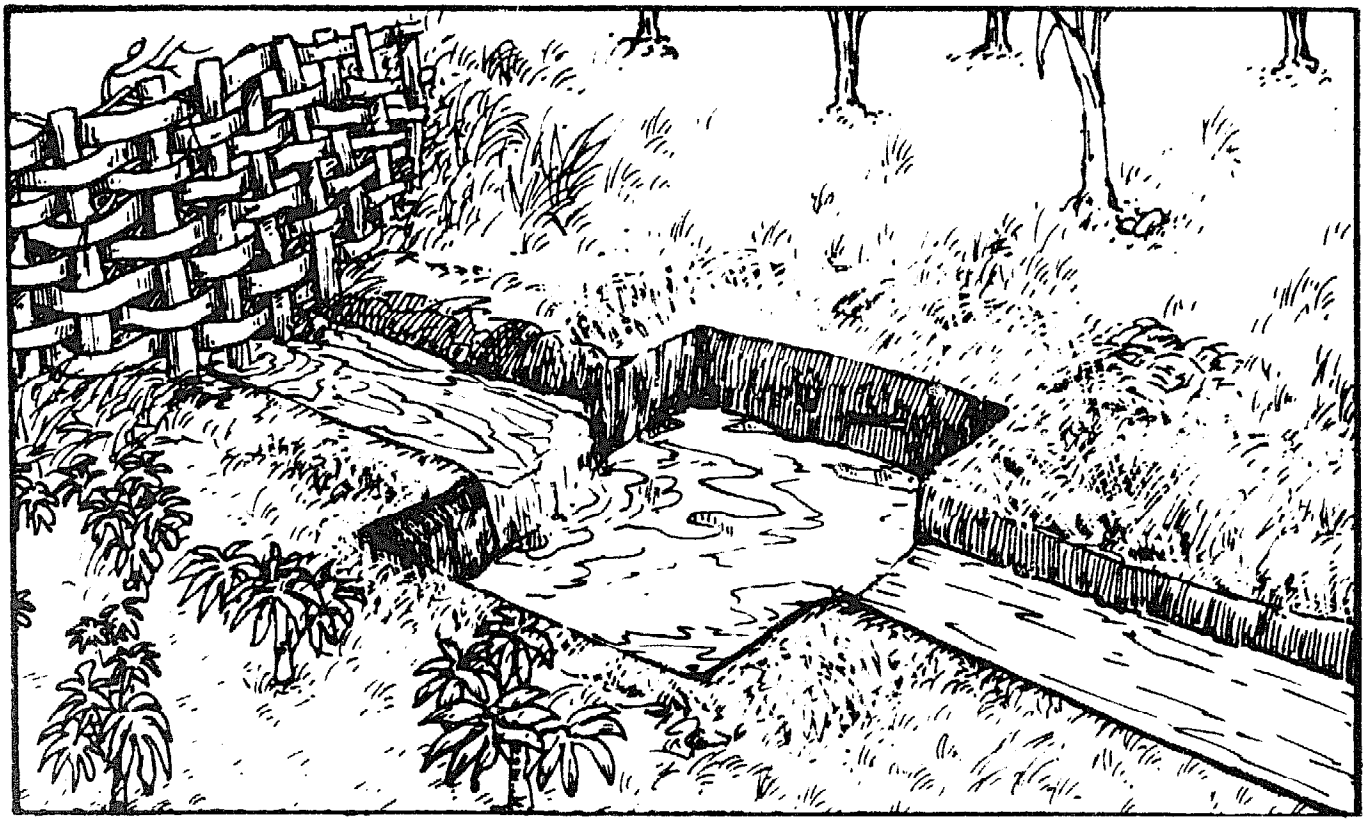
Soil that builds up behind the check dam must be dug out from time to time so that the dam will not overflow.



"Soil traps" are pits dug into the ground that water must pass through on its downhill flow. These pits are placed in drainage canals to slow down the flow of water and trap soil being carried by the water. Soil traps are made by digging a pit approximately one meter wide and long and one half meter deep.



As the water loses speed, the heavier soil particles will settle to the bottom of the trap. After heavy rains, the soil trap should be checked and cleaned out. The soil from the pit can be deposited onto the nearby field.

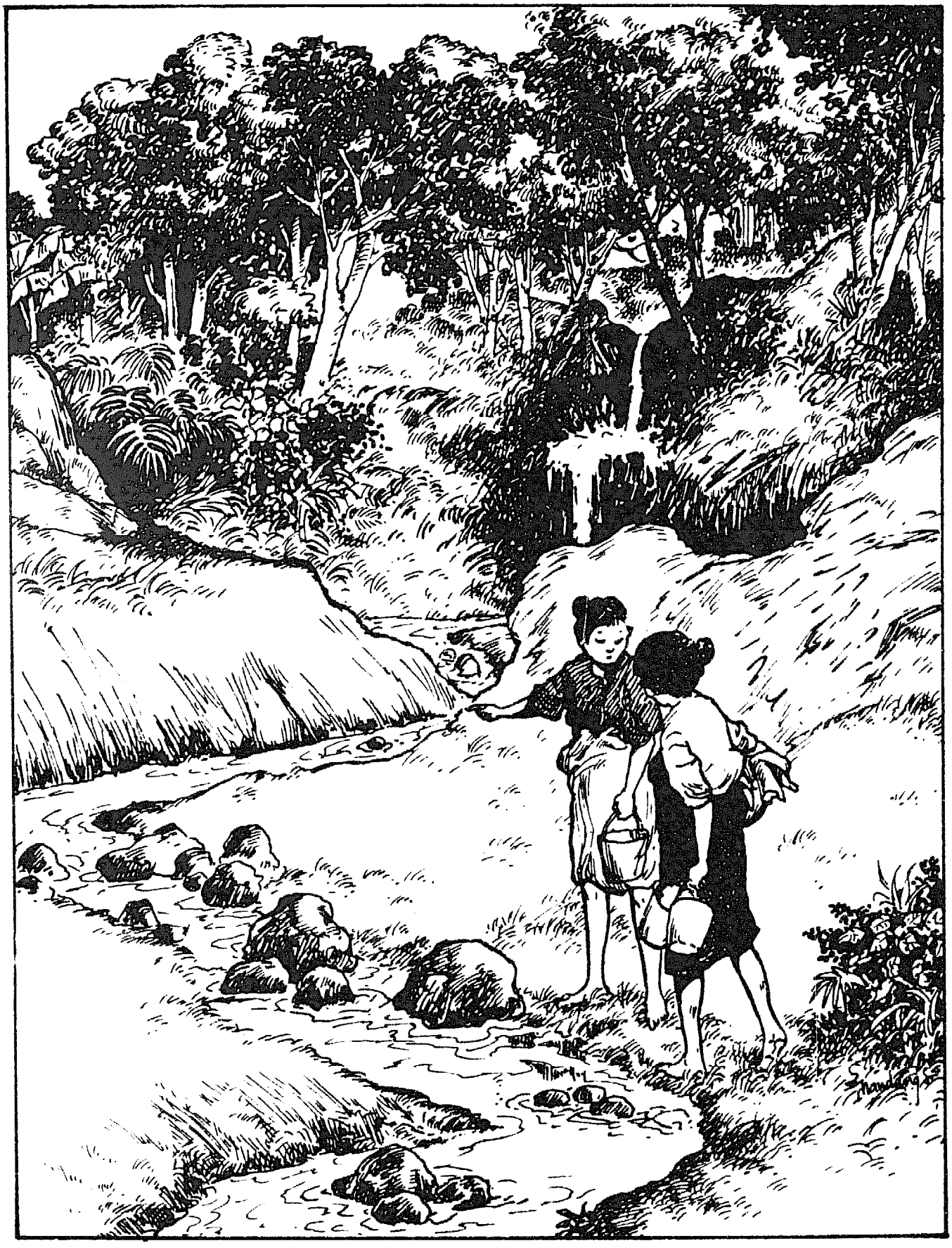


Soil traps can be combined with check dams. The soil trap is placed either above or below the check dam, which will ensure that even more soil is conserved.

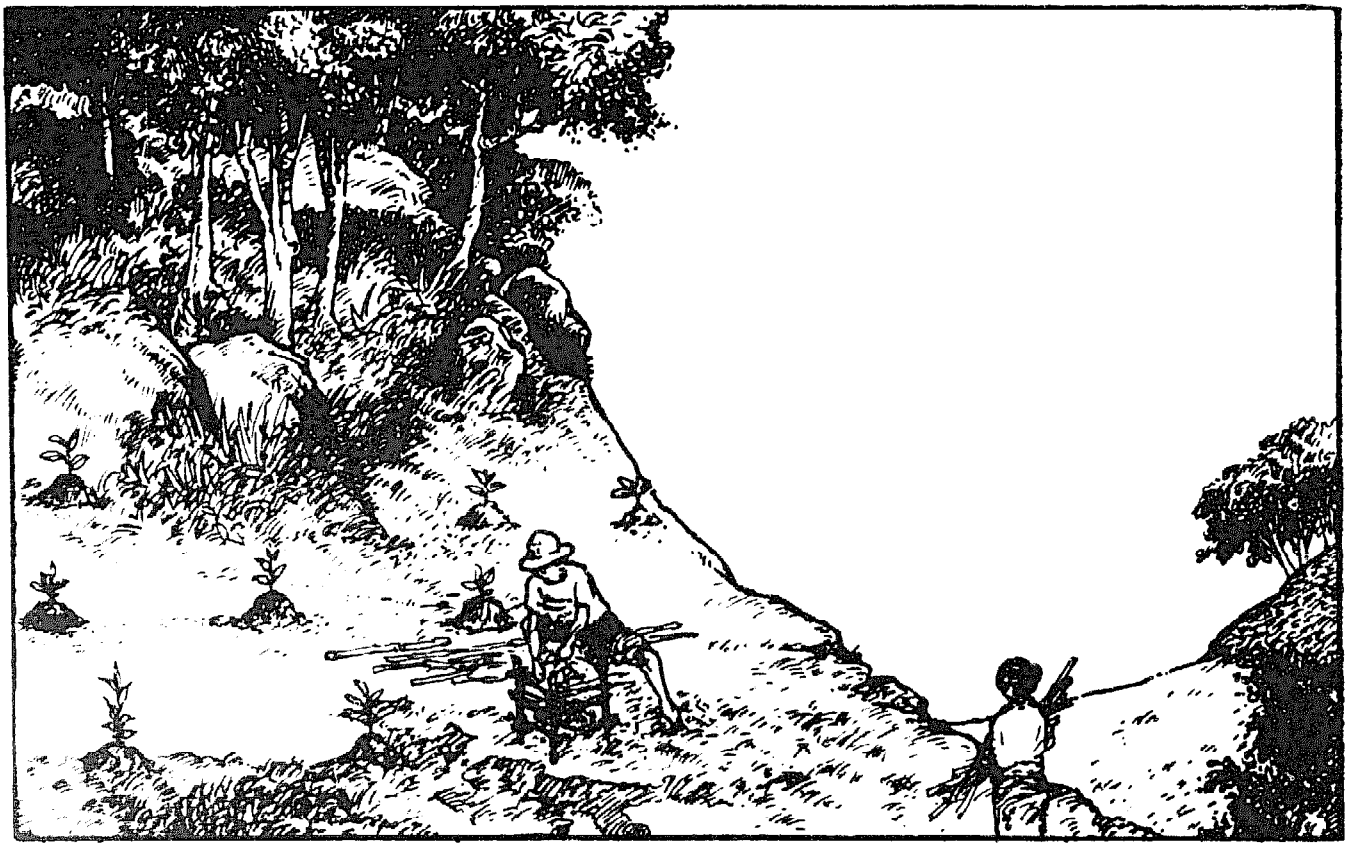
Farmers have also used larger soil traps (one cubic meter or larger) as sources of water for crops, or for use with pesticide sprayers.

Drainage canals, check dams and soil traps are usually located between neighboring farms. Both neighboring farmers, then, will benefit from their construction. Naturally, they should both agree to cooperate in construction as well as in the maintenance of these structures.

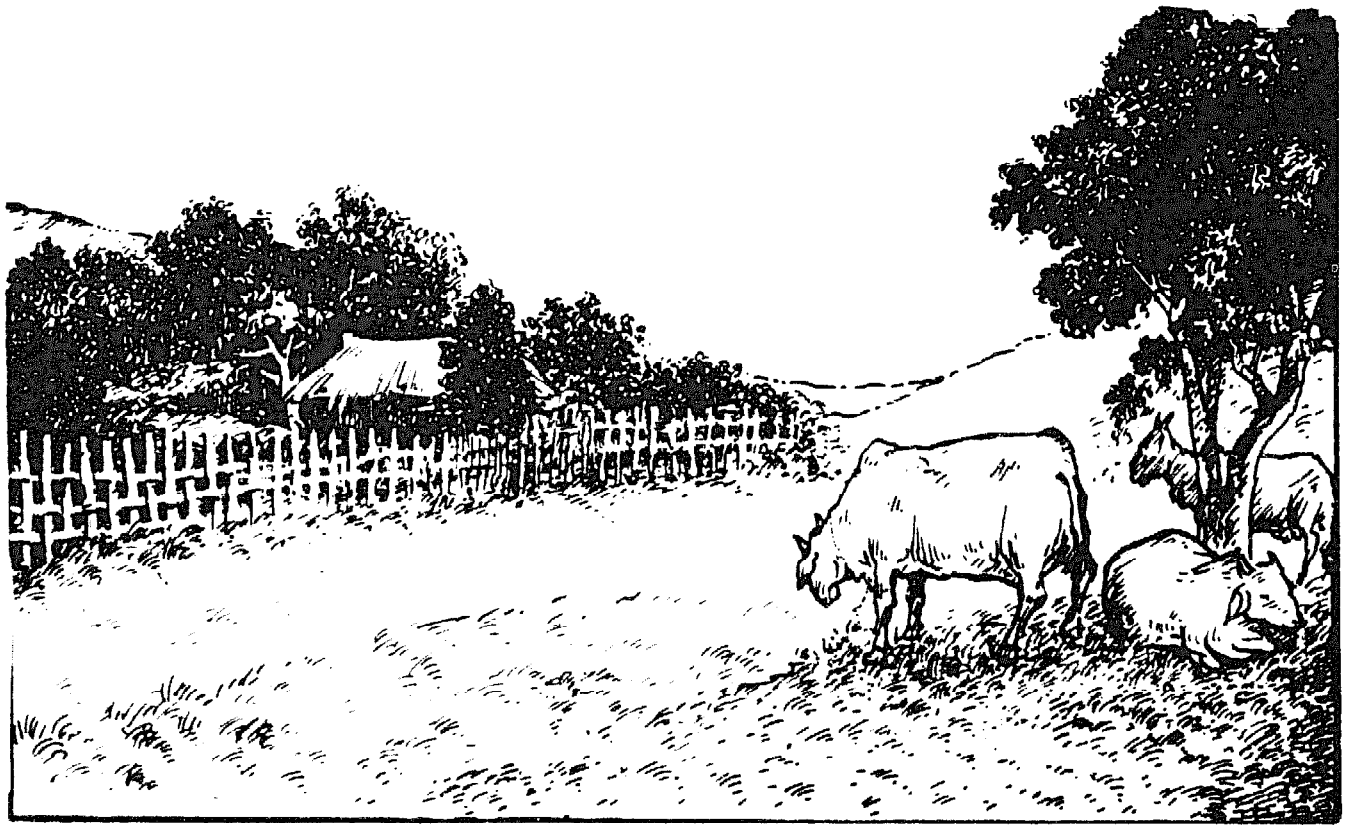
LAND USE



Aside from the practices already discussed, there are still many other issues for farmers to think about in planning for the best **long term** use of both their own land and the common land surrounding the village. For example, land around natural springs should always be protected with forest cover.



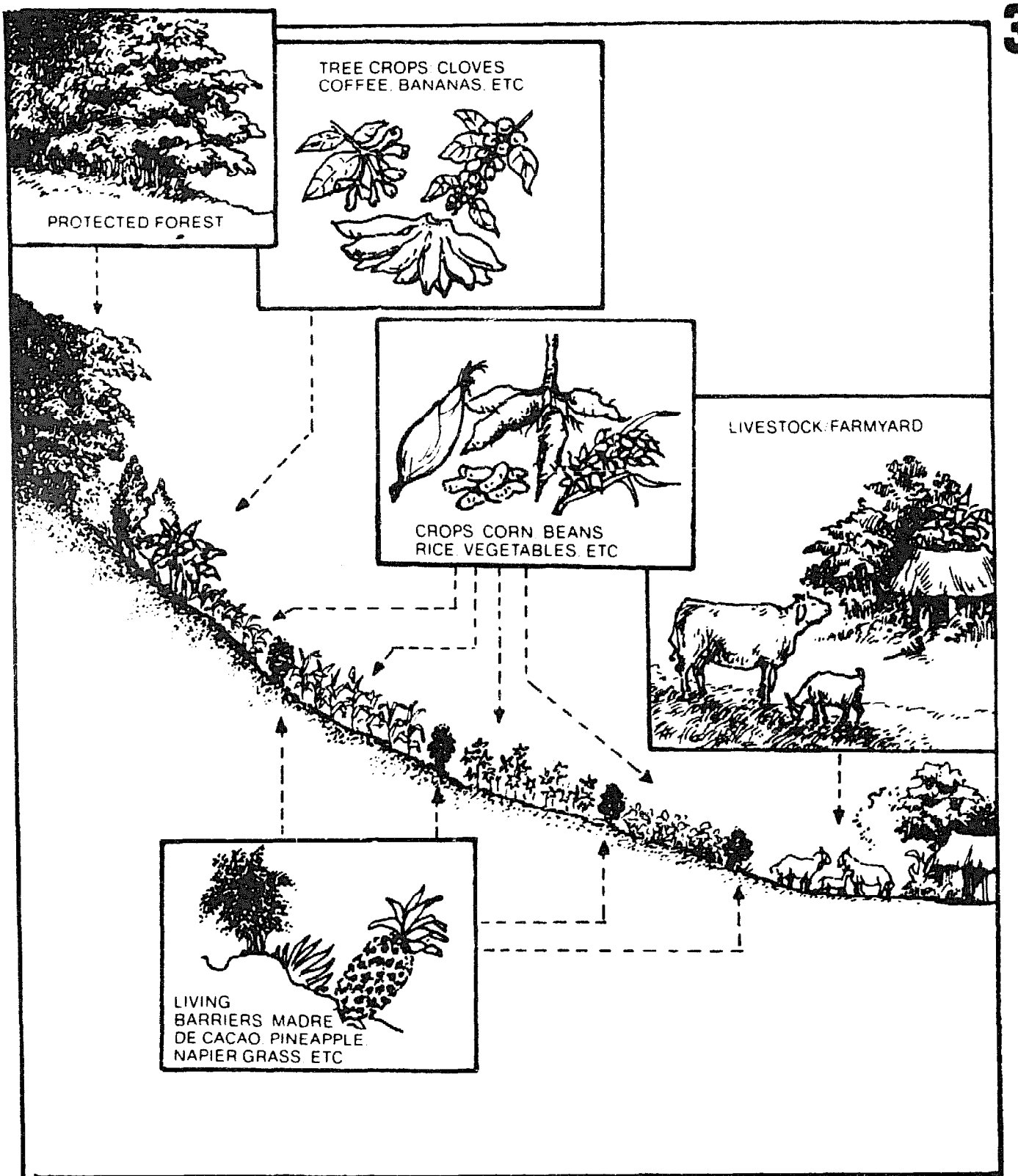
Land that is very steep or located near the tops of hills is best used for planting trees, especially those that can add to farm income or be used for firewood. Examples of useful trees to consider are fruit trees, cash crops like coffee, cacao, and cloves, and a range of afforestation species.



Open lands that are not productive for farming may be designated as grazing areas for livestock.

We must assess our land carefully and decide upon the best way to use it. But, regardless of how we use our land, proper soil and water conservation practices must be carried out so that the land can continue to be productive.

The forest cover on very steep land, such as that located near the tops of hills or bordering river basins, should be preserved. Even though this type of land is often not suitable for agriculture, we must protect these areas by developing them so that they can be more useful over the long term.



In many countries, the government has grouped lands according to their capability and use. The purpose of such "**land use classification**" is to recommend the best use of land for different soil types and conditions. When planning for the best long term use of our land, we should consider this information carefully if it is available.

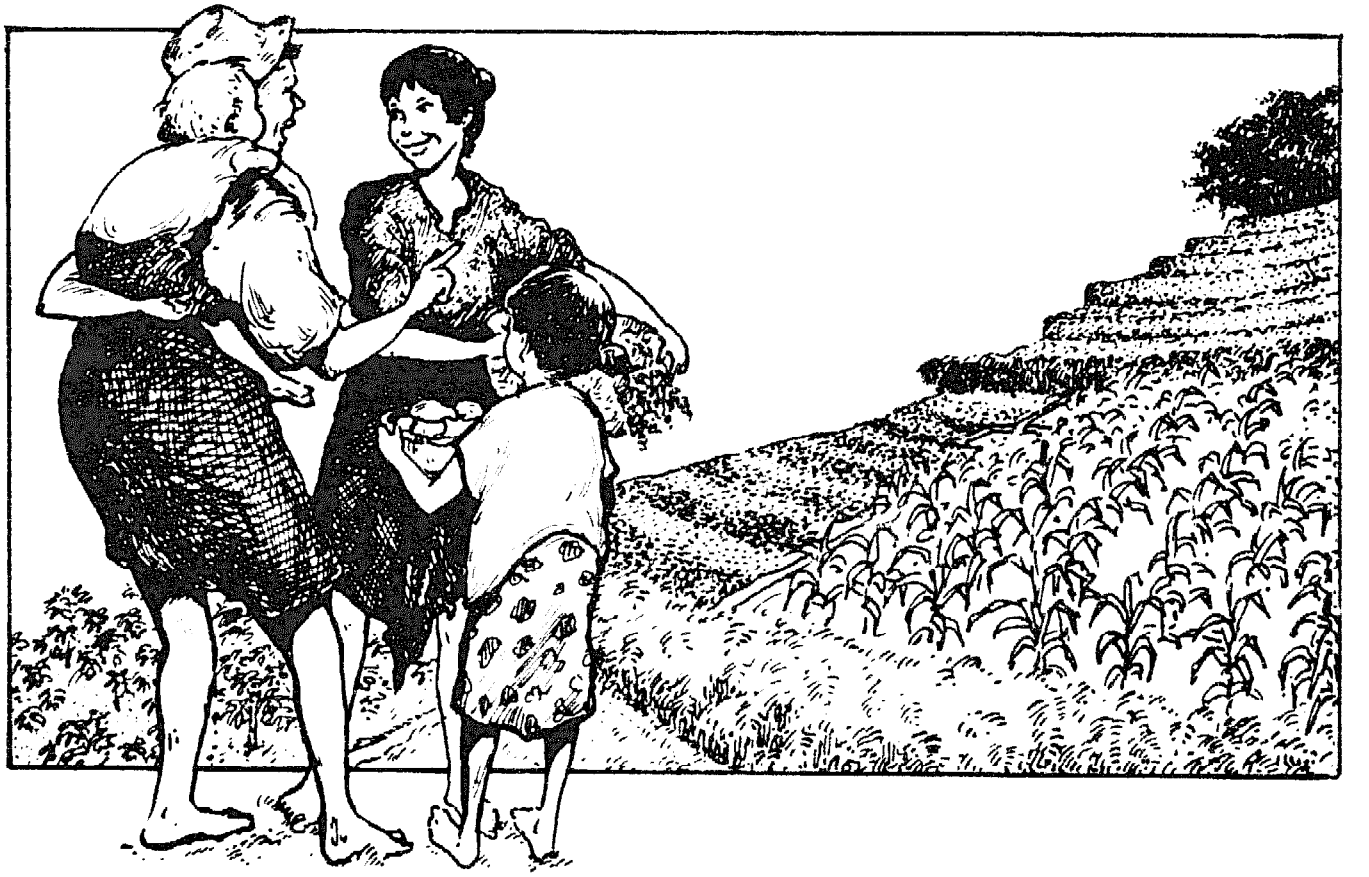
We can develop good land management practices ourselves that which are suitable for field conditions on our own farms. We should also discuss our ideas about land use with our neighbors and begin working toward wider benefits for the whole village.

CONCLUSION

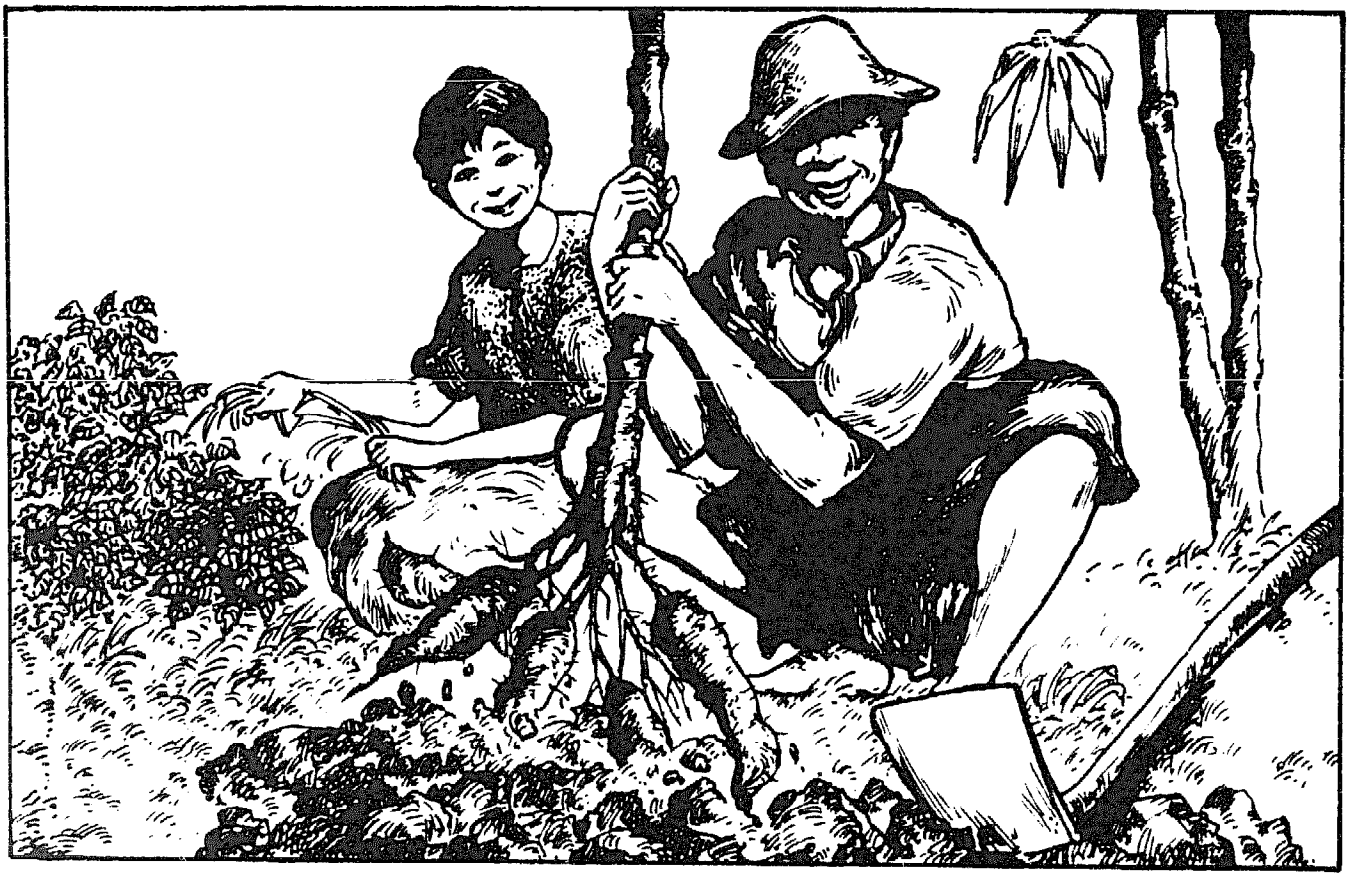
Several soil and water conservation practices have been explained in this booklet. We should think carefully about our needs as farmers and decide on how to best adapt these practices for our own conditions.

We should always remember the three basic principles in adopting any soil conservation practices:

1. EROSION CONTROL
2. MAINTENANCE OF SOIL FERTILITY
3. CONTROL AND ABSORPTION OF SURFACE WATER



Using proper soil and water conservation practices will not only save our most precious resource, but will inc ease our harvests and make our farm more productive and even more beautiful.



The methods described here are simple, but do require hard work and determination. Once the structures are completed, they will require regular maintenance — but, it is important to remember that soil and water conservation is the foundation for any long term efforts in productive farming.

Other booklets of the *Practical Guide to Dryland Farming Series* cover additional methods that can be used to improve dryland farm management. Remember that NOW is the time to begin to work toward a more fertile, productive farm while conserving the environment in which we work and live.