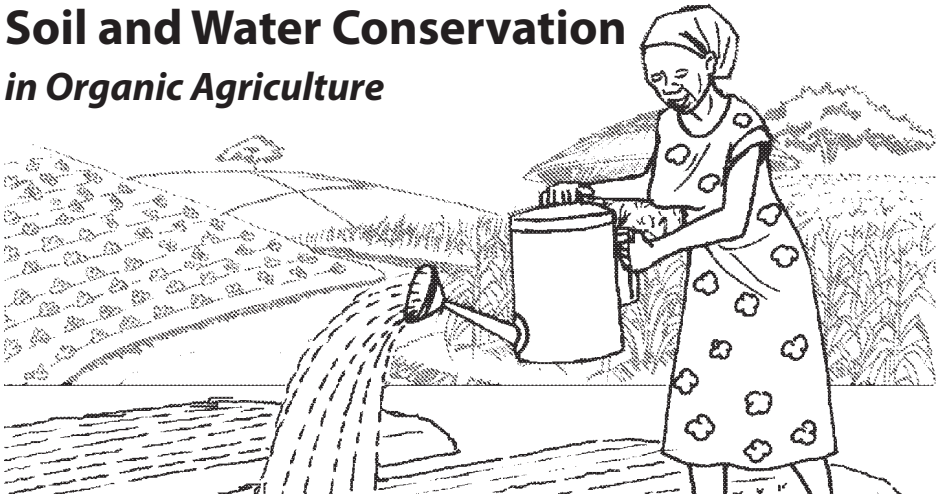
Farmers Training Notes **6**

SOIL AND WATER CONSERVATION
in Organic Agriculture

KOAN

Kenya Organic Agriculture Network

Soil and Water Conservation
in Organic Agriculture



Introduction

Soil and water conservation in organic agriculture is very important since crops need well drained and fertile soils to germinate, grow and mature. Infertile soil is easily carried away by either wind or rain water as it has nothing binding it together. Too much water can cause water logging or erosion while very little may not be sufficient for crop production. This pamphlet will focus on both soil and water conservation as they are vital for crop growth and productivity.

What is soil conservation?

Soil conservation means reducing the amount of soil erosion and maintaining soil fertility. It involves increasing the amount of water seeping into the ground, reducing the speed of water running off and keeping enough vegetation to protect the soil surface and bind it together.

In sustainable land use, production must be combined with conservation of the resources it depends on. Therefore, soil conservation efforts should:

- Control erosion sufficiently
- Maintain soil organic matter by covering (mulching) the soil, leaving the crop residues, green manuring and application of compost or *boma* manure, among others
- Maintain the soil physical properties like structure
- Maintain appropriate levels of soil nutrients through rotation, prevention of water run off, as well as performing required soil amendments.

What is soil erosion?

Soil erosion will occur when soil particles become loose and are carried away by water or wind. When it rains heavily, the soil becomes saturated with water, to the point that no more water can seep through. The excess water flows down the slope, carrying soil particles with it. In short, soil erosion is the process by which the top fertile soil is carried away by wind, animal movement or running water. Soil erosion is mostly common on cultivated soils, steep slopes, and on land where the vegetation cover has been removed or where there is intensive rainfall.

How to recognize soil erosion

There are several ways in which soil erosion can be recognized in a given area. Some of the signs of erosion include:

- **Appearance of small furrows**
  After it has rained, the farm is left with small linear depressions on the soil surface. These depressions are a clear indication of low intensity rainfall on a bare soil surface.
- **Deposit of fine soil particles**
  This is especially pronounced where there are conservation trash lines, contour banks, fence lines, on flat river banks and flood plains. Sometimes crops will be covered by soil deposited where they are growing.
- **Colour of running water**
  The water running down the slope when it is raining looks brownish in colour. Water in rivers and earth dams changes colour due to soil particles that are deposited into them by rain water running down the slope.
- **Eventual appearance of gullies**
  Under severe soil erosion conditions, deep and sometimes impassable trenches will form, especially after long rains. Crops get uprooted and carried away. The roots will be left exposed after the soil has been carried away by running water.

Why conserve the soil?

The main reasons for conserving the soil include:

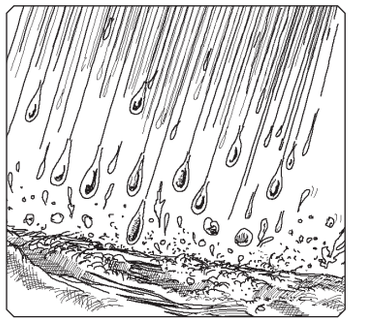
- To control soil erosion and prevent loss of valuable nutrients from the soil – lost soil from the field is equivalent to lost cash in hand
- To enable soil fertility to build thus improving the crop or pasture yields
- To increase the value of the land
- To make terraces which make cultivation on steep slopes easier
- To provide fodder from grass strips, hedge barriers and terrace embankments
- To create employment opportunities in soil conservation work
- To improve the supply of fuel and forest products

Types of soil erosion

There are four types of soil erosion that take place when it rains. These include:

1. Rain-drop or splash erosion

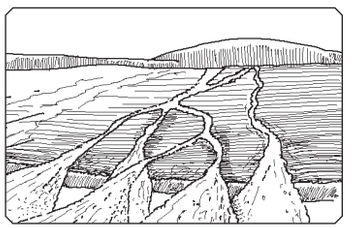
This type of erosion occurs when drops of rain fall on unprotected ground (bare soil). The impact of water on the soil splashes away the soil particles, digging a crater. When it rains and there is a sufuria or drum left outside, you are likely to find it soiled on the sides. Splash erosion can also be seen when water drops from the roof of a house that has no gutters. You will find that the water drops repeatedly on the ground leaving a crater and some of the soil splashed on the wall of the house.



Rain-drop or splash erosion

2. Sheet erosion

Sheet erosion occurs when a thin layer of the top soil is moved by the force of running water, leaving the surface uniformly eroded. Many farmers may not recognize that their top soil is being carried away where this type of erosion occurs. It mostly occurs on farms with very gentle slopes or farms that appear to be level whereas they are not.



Sheet erosion

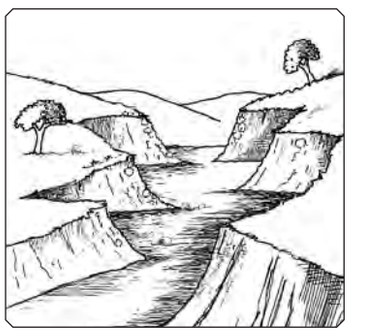
3. Rill erosion

Rill erosion is caused by water run-off that creates small linear depressions in the soil surface. These are easily removed during land tillage.

Rill erosion

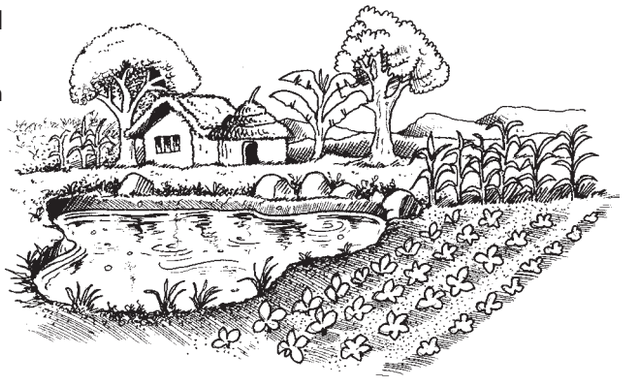
4. Gully erosion

Gully erosion, unlike rill erosion, forms deep gullies that cannot be removed during normal tillage (cultivation) with ordinary farm implements. The gullies start to form as small depressions which concentrate water and enlarge, eventually forming a channel. The deepening channels undermine the head wall, which retreats up-slope. The gully then widens as the side walls are worn back.



Gully erosion

WATER CONSERVATION



There is very little difference between water conservation and soil conservation. In most cases, we find that arid and semi-arid areas receive rains that are not reliable in certain months of the year. In the months the rains are expected, they may come in a few heavy storms, with most of the water running off the surface causing flooding and erosion. Soil and water conservation is concerned with trapping or harvesting as much of this water as possible and storing it for use after the rain has stopped, as most of the times it does not rain long enough to take crops to maturity. The running water can be trapped in dams, terraces or other water reservoirs which will allow it to seep into the soil slowly and raise the under ground water table as well as increase the soil moisture levels.

More water can seep into the ground if it is spread over a large area of soil rather than being concentrated in fast running streams. Water conservation efforts focus more on ways that will stop the water from becoming concentrated by ensuring a protective cover of vegetation on the soil surface. This will slow down the flow of running water. Good examples are pits and dams for slowing down the flow of running water and contour ditches to spread the water out over a large area.

Advantages of water conservation

- It makes water available for crops, livestock and domestic use over a long period.
- By controlling soil erosion, the soil will maintain its fertility which in turn will give better crop or pasture yields
- It improves the availability of fuel and plant products like fruits, nectar and dye among others through Agro-forestry practices and self will of cutting one tree and planting two
- It increases the value of land
- Terraces will make it easy to cultivate on the steep slopes
- It makes more fodder available. An example is the grass from grass strips, hedge barriers and the terrace embankments
- It provides employment opportunities in soil and water conservation work

Disadvantages of water conservation

- Fragmented land ownership makes it difficult for farmers to invest optimally in soil and water management systems in some parts of the country.
- Conservation structures need a lot of labour to build and maintain
- Crop production in semi-arid areas involves a lot of risks, including flooding. This makes it difficult for farmers to realize the full benefits of conservation.
- Many farmers lack the skills to design and build conservation structures, hence sub-standard and poorly constructed structures often result.
- Land tenure systems determine the ownership of the structures and influence farmers' interest in conservation and maintaining the structures.
- Irregular rainfall reduces the effectiveness of vegetative erosion control practices.

SOIL AND WATER CONSERVATION MEASURES

There are many ways of conserving soil and water. These can be divided into cultural or agronomic measures which include vegetation and soil tillage practices and physical conservation measures which involve building permanent structures like soil banks or stone buds to control the flow of water.

1. Cultural or agronomic measures

Crop management

Good crop management reduces erosion by water and wind to tolerable levels and can improve soil fertility. Select appropriate crops for the soil and slope, do early crop planting, use suitable cropping systems, follow proper crop rotation and plant cover crops to keep the soil covered.

Tillage methods

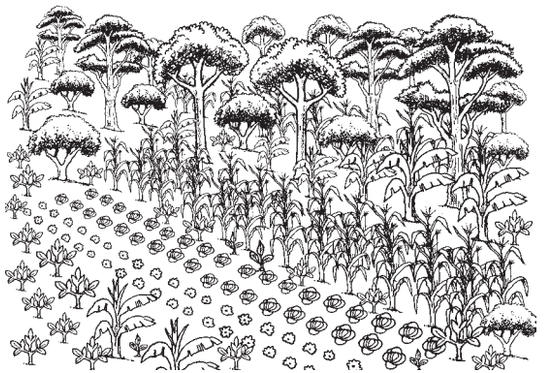
Tillage aims to optimize soil physical and biological conditions for crop production, and ensure timely seedbed preparation, planting and weed control. Use a tillage method that does not make the surface soil too fine and powdery. Break up the hardpan if necessary.

Applying Organic matter

Regular application of organic matter to the soil provides the required plant nutrients for vigorous crop growth. This covers the ground quickly, protecting it from erosion and allowing water to seep for use by crops, resulting in better yields. The organic matter also improves the soil structure and water holding capacity.

Agro-forestry

Agro-forestry involves planting trees or shrubs in the farm, or keeping those that are already there. Trees conserve the soil in many ways. They cushion the impact of raindrop



on the soil, thus reducing the amount of rain-splash (drop) erosion. Their roots bind the soil together. Planting trees along the contours will interrupt the flow of water running off the surface. They shade the soil, reducing the soil temperatures and the amount of water that evaporates into the air. Trees break the wind, reducing the impact of wind erosion. They recycle nutrients from deep in the soil while leguminous trees fix nitrogen that can be used by food crops. Trees offer many other ecological, economic and social benefits that include fodder, fuel (fire wood and charcoal), timber or building poles, fruits and dyes among many others.

Contour farming

Contour farming involves ploughing, planting and weeding along the contour, i.e. across the slope rather than up and down. On a moderate slope, experiment has shown that contour farming can reduce soil erosion by as much as 50%. For farms with slopes steeper than 10%, the farmer is advised to combine contour farming and other soil conservation measures to effectively control soil erosion. Some of these include:

- **Contour ridges -** Contour ridges are used mainly in semi-arid areas to harvest water and in higher rainfall areas for growing potatoes.
- **Trashlines -** Trashlines are made by laying crop residues or trash in lines along the contour. They slow down runoff and trap eroded soil, eventually forming terraces. However, the contour lines made from trash or crop residues are easily destroyed by termites.
- **Grass barrier strips -** These are grass barrier strips planted along the contour. They are planted with fodder grass such as Napier, or often left with natural grass. They are effective soil conservation measures on soil that absorbs water quickly.

Most of these cultural or agronomic measures are suitable mostly in arid and semi-arid areas.

2. Physical Conservation Measures

Physical conservation measures are the permanent features made of earth, stones, or masonry. The features are designed to protect the soil from uncontrolled rain water runoff that causes severe erosion, and retain that water where it is needed.

They supplement cultural measures (agronomic or vegetative) but do not substitute (replace) them. The appropriate types of physical structures to be put in place depend on different factors that include climate and need to retain or discharge the runoff, farm size, soil characteristics like texture, drainage and depth, availability of an outlet or natural water way, labour availability and cost and the adequacy of existing crops / vegetative conservation measures.

Some of the common soil erosion control structures include:

Cut-off drains

Cut-off drains are dug across a slope to intercept surface runoff and carry water safely to an outlet such as a canal, dam or stream. They are used to protect cultivated land, home compounds and roads from uncontrolled rain water runoff. This runoff can cause gullies and it is important, therefore, to divert water from gully heads. Farmers are not allowed to make cut-off drain terraces on their own as they may drain water to their neighbours' farms.

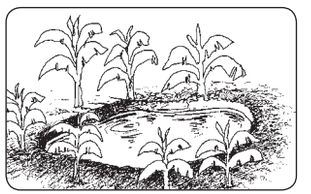
Retention ditches

These ditches are dug along the contour. They catch and retain in-coming runoff and hold it until it seeps into the ground. They are an alternative to cut-off drains when there is no nearby waterway to discharge the runoff into. They are the first ditches dug to hold roadside or home compound runoff. They are often used to harvest water in semi-arid areas

Infiltration ditches

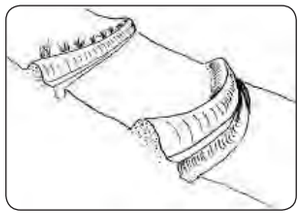
Infiltration ditches are one way of harvesting water from roads or other sources of runoff. They consist of a ditch, 0.7 - 1.5 metres deep, dug along the contour, upslope of a crop field. Water is diverted from the roadside into the ditch, which is blocked at the other end. Water trapped in the ditch seeps into the soil. On soil with an impervious layer (such as a hardpan) below the surface, the water does not sink straight down into the soil. Instead, it moves downslope just below the surface, towards the crop in the field below. Infiltration ditches are more or less the same as retention ditches.

Water-retaining pits



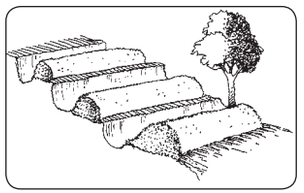
Water-retaining pits trap runoff and allow it to seep into the soil. A series of pits are dug into the ground where runoff normally occurs. The soil from the pits is used to make banks around the pits. Furrows carry excess water from one pit to the next. The size of the pits depends

on the amount of run-off to be collected. It is advisable to plant bananas and other tree crops around the pits.



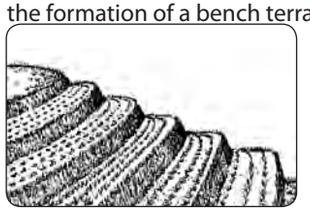
Fanya juu terraces

Fanya Juu terraces are made by digging a trench along the contour and throwing the soil uphill to form an embankment. The embankments are stabilized with deep rooting fodder grasses like Napier and Vetivar grass. The space between the embankments is cultivated. Over time, the *Fanya juu* develop into bench terraces. They are useful in both high rainfall and semi-arid areas to harvest and conserve water.



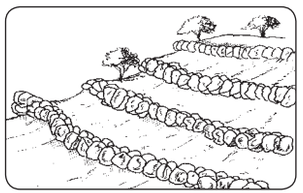
Fanya chini terraces

A *Fanya chini* terrace is like a *Fanya juu* , except that the soil is put on the lower side of the contour trench, not on the upslope side of if as in a *Fanya juu*. *Fanya chini* are used to conserve soil and divert water. The resulting embankment can be used to grow fodder. *Fanya chini* are easier to make than *Fanya juu,* but they do not lead to the formation of a bench terrace over time.



Bench terraces

Bench terraces are level or nearly level steps constructed on the contour, and separated by embankments. They can be formed by excavation or may develop over time from a grass strip or *Fanya juu*.



Stone bunds terraces

Stone bunds terraces are useful in areas with steep slopes and many stones scattered all over the farm and where digging is not possible. The terrace risers are made of stones collected from the land. The terraces themselves can be sloping or level.

Making contour lines

Many farmers may want to mark contour lines (level lines running across a slope) to decide where to dig contour canals, lay down the trash lines or plant trees. To achieve this requirement, a simple devise called the A-frame is used. The A-frame can be used to mark contours, but can also be used to mark graded terraces or to measure the slope of a field.

Advantages of the A-frame

- It is a simple devise that is easy to use
- The A-frame only needs two people to work with it
- They can be made from locally available material.

Disadvantages of the A-frame

The A-frame is not practical for making contours over large distances.

Using the A-frame

An A-frame consists of three pieces of wood, fixed together in the shape of a capital letter 'A'. The A-frame is held upright and a weight on a string hangs down from the top of the "A" to act as a plumb-line. If the A-frame is on a perfectly level ground, the string crosses the horizontal bar of the "A" at a certain point. This point is marked during calibration.

To use the A-frame, it is "walked" across the slope, making sure that the two legs are level each time by checking if the string crosses the horizontal bar at the calibrated point. If not, the forward leg is moved until the string shows the frame is level. The position of the legs on the ground is marked with pegs, and then the frame is pivoted around to mark a new point on the slope.

Equipment required to make A-frame

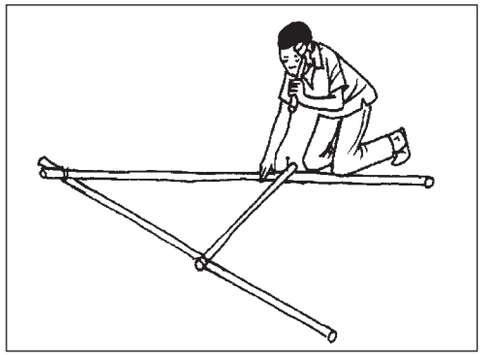
Two straight wooden poles (6 – 8ft long), one straight pole (5 –6 ft long) and two pegs about half a metre long, a long string, a hammer, nails, pencil, ruler and a round stone.

Making the A-frame

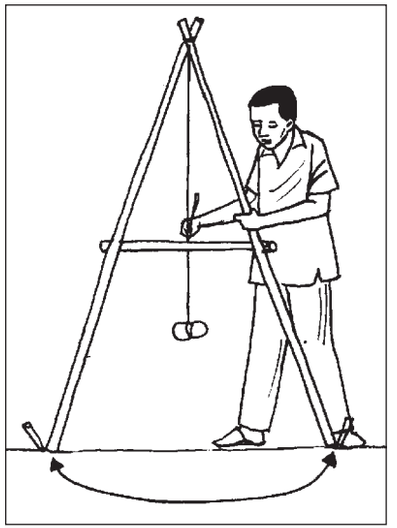
1. Use the poles and nails to make the A - frame in the shape of capital letter 'A'. First cross two poles at the top and nail to fasten them together.
2. Tie the third pole across the other two to form the letter 'A' and fasten them with nails.
3. Tie one end of the string at the top of the A and let it hang down below the crossbar.
4. Tie a stone at the end of the string, so it hangs down just below the horizontal crossbar of the A but high enough not to touch the ground.
5. At this point, the A-frame is almost complete but before it can be used to make a contour, a central point must be found on the crossbar which indicates when the two legs of the A are level.

Calibrating (marking) the A-frame

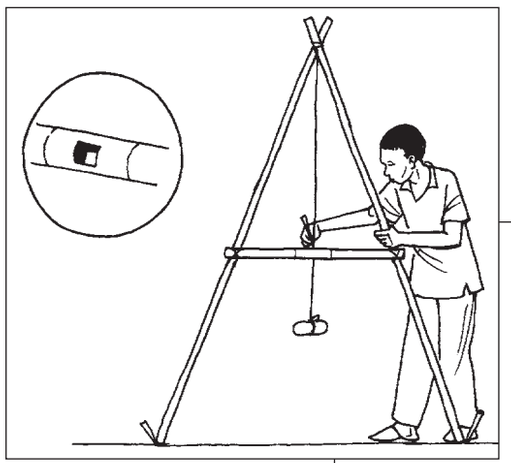
6. Stand the A-frame upright on reasonably level ground. Mark on the ground where the two legs stand using pegs.
7. Hold the A-frame still, and use the pencil, chalk, charcoal or panga to mark lightly on the crossbar where the string crosses the A-frame.



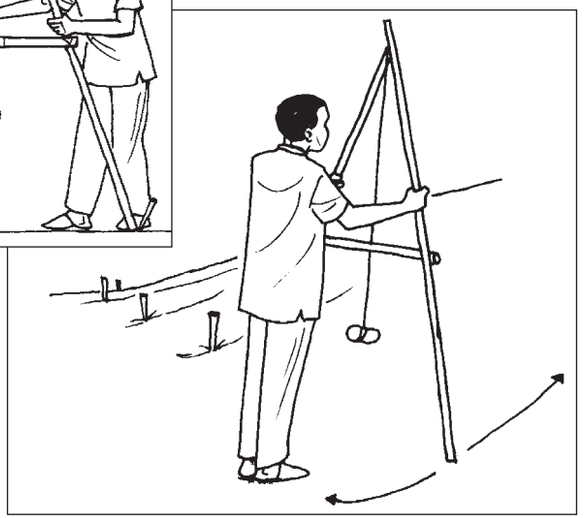
(A) *Use the poles and nails to make the A - frame in the shape of capital letter 'A'. First cross two poles at the top and nail to fasten them together*



(B) *Stand the A-frame upright on reasonably level ground. Mark on the ground where the two legs stand using pegs.*



(C) *Hold the A-frame still, and use the pencil, chalk, charcoal or panga to mark lightly on the crossbar where the string crosses the A-frame.*



(D) *Choose a place on the slope where the contour barrier is to be constructed. It is good to start at the top of the field. Stand the A-frame up and mark where the first leg stands with a peg or large stone.*

8. Turn the A-frame round, so that each leg stands exactly where the other had stood. That is, leg one touches peg two while leg two touches peg one.
9. Make a second light mark on the crossbar where the string crosses the bar. Usually, the marks will be at different points. If the ground is level, the two marks should be at the same point.
10. The two marks on the crossbar should be fairly close together. Halfway between them shows where the string would cross if the A-frame was standing on exactly level ground. Make a heavy pencil mark or notch the bar with a knife at this point.

11. When the weighted string hangs directly in front of the cut notch, then the two legs are in a level position.

Making the contour

12. Choose a place on the slope where the contour barrier is to be constructed. It is good to start at the top of the field. Stand the A-frame up and mark where the first leg stands with a peg or large stone.
13. Keeping the A-frame upright, and without moving the first leg, swing the second leg up or down the slope until the string crosses the crossbar exactly at the heavy pencil mark.

14. Mark where the second leg stands with another peg or stone.
15. Keeping the second leg in the same place, lift the first leg up and pivot it around. Move it up and down the slope until you find the place where the string crosses the crossbar at the heavy pencil mark.
16. Mark where the first leg is now standing with another peg or stone.
17. Continue in this manner to the end of the field.
18. The line of pegs or stones will mark a contour line; they will all be at the same height on the slope. The pegs are usually not in a straight line. If necessary, make a smooth curve by moving them a little up or down.
19. To mark another contour line, move up or down the slope a certain distance –usually about 20m (20 steps) on a gentle slope, or a drop of 1.5 m (5 ft) on steeper slopes. Repeat the process from step 9 above onwards.
20. You can then dig ditches, construct terraces, make trash lines or plant trees along the contour line using the pegs or stones as a guide.

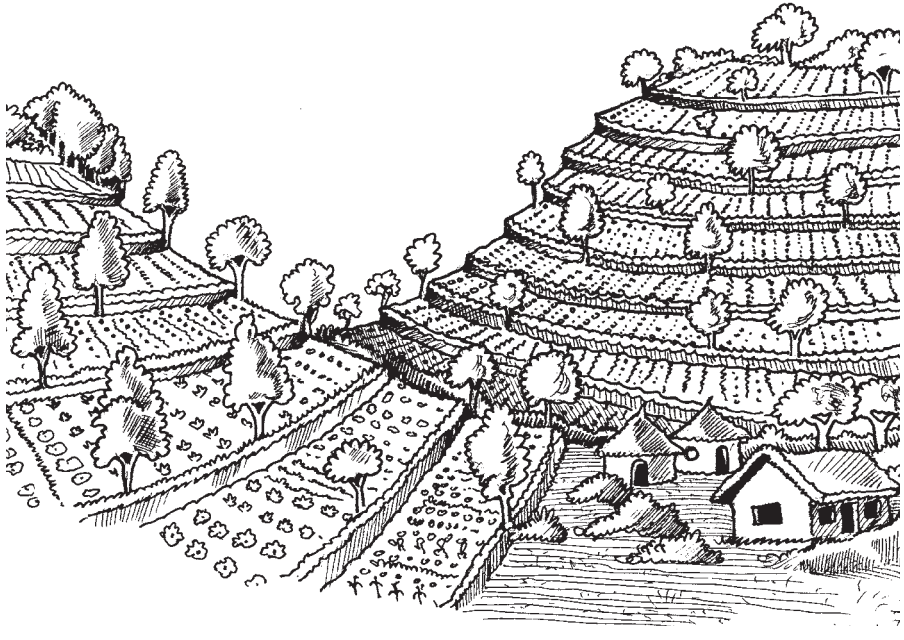
USING AN A-FRAME TO MARK OR "GRADE" THE SLOPE OF THE FIELD

An A-frame can also be used to "grade" a field or a drainage canal to achieve a certain slope. This can be useful as it allows a farmer to ensure proper drainage of a field.

Once you have assembled the A-frame following the directions discussed earlier, you need to calibrate it. However, if the A-frame is to be used to grade the slope, the calibration procedure is different as follows:

1. Decide what percentage slope you want the field or drainage canal to have. For this example, let's say you want a 6% slope.
2. Cut a small block of wood 12cm high. The height of the block for other percentage slopes will be either more or less than this.
3. Place the block on level ground against a wall so that it does not move. Place a straight, 2-metre-long board or pole on top of the block, with the other end resting on the ground. Place a heavy stone against that end so that the board does not move. Do not stand on the board when marking the A-frame.
4. Place the A-frame on the board, and mark where the string passes on the crossbar of the A-frame. The A-frame is now calibrated; when the string aligns with the mark on the crossbar, this indicates a 6% slope.

5. Use the A-frame to mark out the slope of a field or drainage ditch, following the same procedure as described above for making a contour. Move one of the A-frame legs up and down the field until the string passes through the 6% mark on the crossbar. It is advisable to note as mentioned earlier, farmers should be very careful not to grade the terraces and drain water to their neighbours. Water is only required to be drained into a natural waterway.



Some of the material in this book was adapted from the books below:

1. Sustainable Agriculture – by ILRI
2. Natural Pests and Disease Control – by Henry Elwell and Anita Maas
3. Organic Farming – by John Njoroge
4. Soil Fertility Management - by John Njoroge

BOOKLETS IN THE FARMERS TRAINING NOTES SERIES

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Kenya Organic Agriculture Network (KOAN) is the National Coordinating Body for organic agriculture activities in Kenya. KOAN's mandate is to coordinate, facilitate and provide leadership and professional advisory services to all members and stakeholders in the areas of production, technical training, marketing, certification, lobbying and advocacy. It seeks to promote the organic agriculture movement in Kenya, to evolve and become a highly beneficial and integral industry with direct impacts on the environment, poverty reduction, employment and wealth creation.

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