

# **PART THREE**

## **Technical Section**

# BURKINA FASO

## I. THE AGROFORESTRY PROJECT (PAF)

### HOW STONE BUNDS ARE BUILT

1. Eroded or abandoned land is selected for treatment.
2. Contours for the bunds are surveyed using a water tube level starting at the top of the field and working downwards.
3. Lines are marked on the ground with a hoe.
4. A shallow foundation trench is dug for each bund.
5. Construction begins with large stones in the rear of the trench (downslope side).

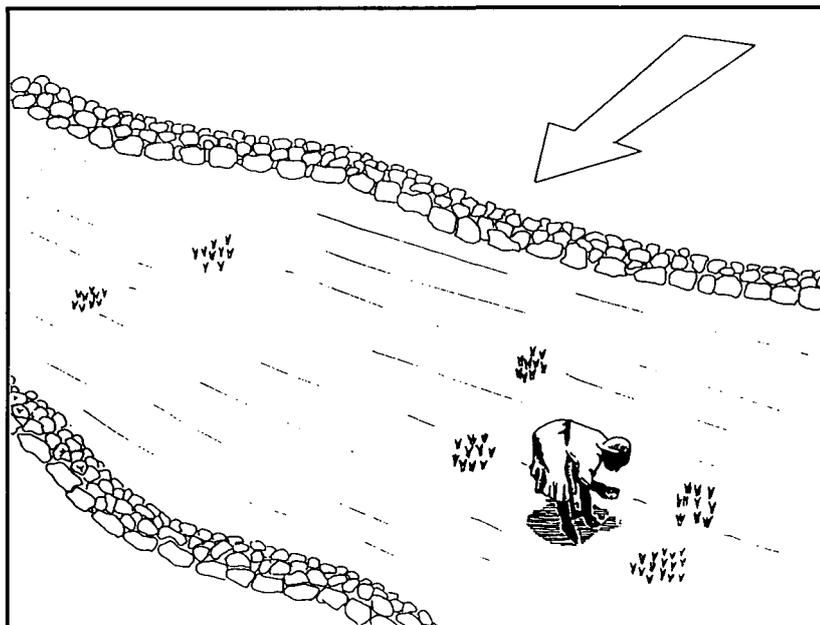


FIG 1: CONTOUR STONE BUNDS

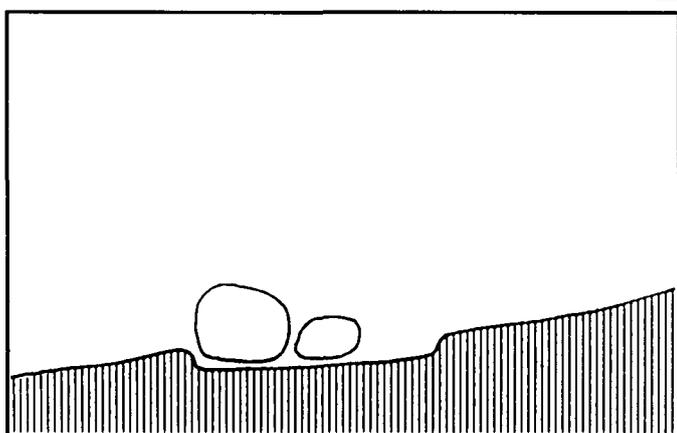


FIG 2a

6. Smaller stones are used to build the rest of the bund. The stones must be packed carefully, especially at the bottom.

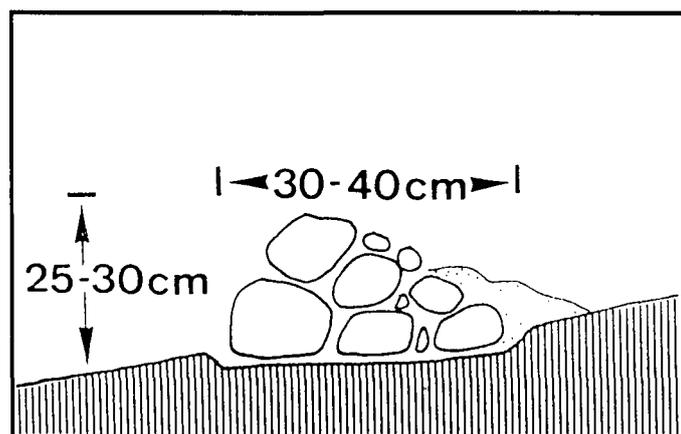


FIG 2b

7. Earth from the trench is piled up in front of the bund.

8. If the land treated is an abandoned plot, the stone bunds are left for a year to catch sediment. Cultivation begins only in the second season.

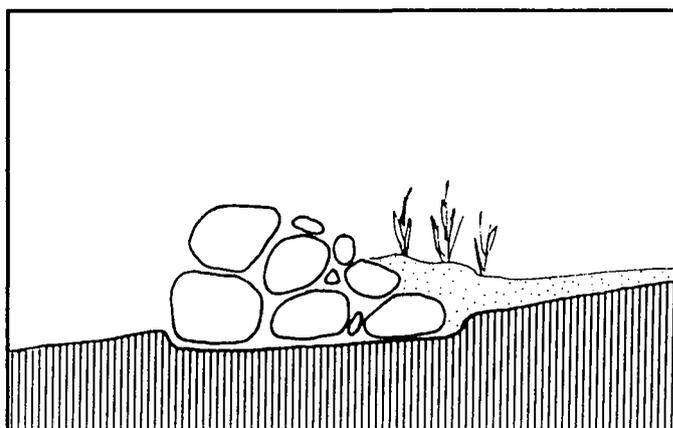


FIG 2c

9. Andropogon grasses and tree seedlings are planted alongside the bund during the rains.

### Measurements

#### STONE BUNDS:

**Spacing:** 15 – 30 metres apart

**Bund:** 25-30cm high and 30-40 cm wide at base

**Foundation trench:** 5cm deep, 30-40cm wide

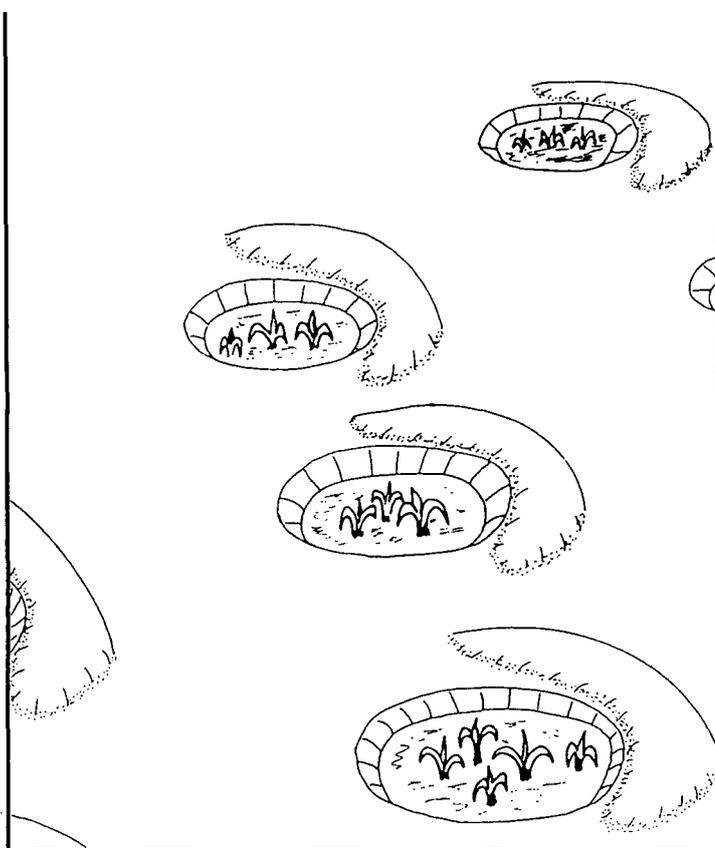


FIG 3: ZAI

## ZAI – (PLANTING PITS)

- *zai* are deep planting pits, which help crop growth
  - they are dug before the rainy season
  - compost or manure is placed in the *zai* to improve fertility
  - *zai* fill up with rainwater runoff during the rains
- Where stone bunds and *zai* can be used:

- suitable for all dry areas
- soils do not need to be deep
- best water harvesting effect on slopes below 2%
- must be a good local supply of stone!

### Measurements

#### ZAI

Spacing: 90cm apart

Size: 30cm diameter; 15-20cm deep

Labour: (stone bunds only) approx. 50-100 person-days/hectare

## HOW TO MAKE A COMPOST PIT

1. A mud wall of not more than 50cm high is built around a pit about 75cm deep. The area enclosed should be 3 metres x 6 metres.

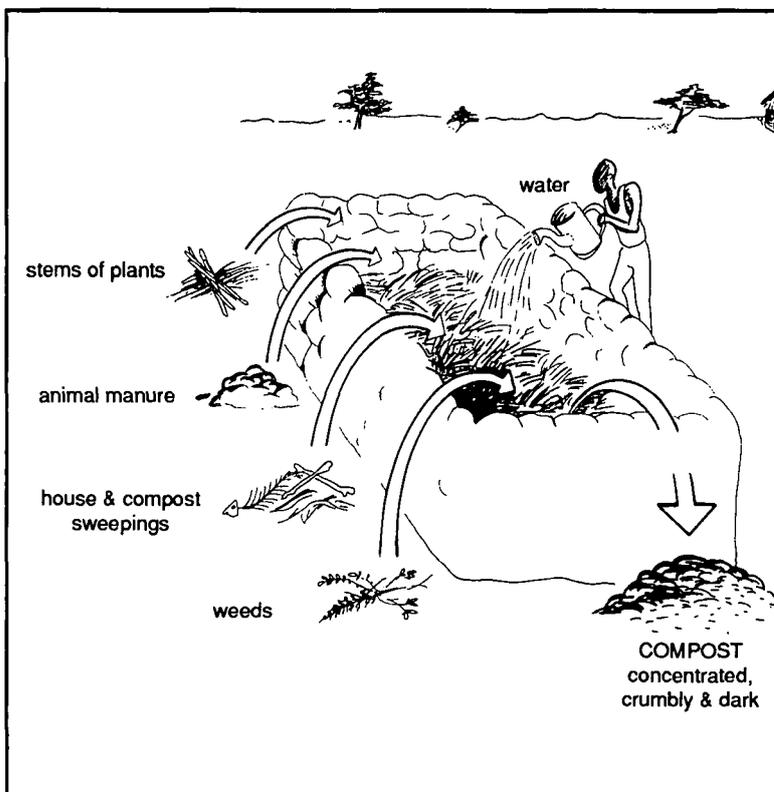


FIG 4: COMPOST PIT

2. A layer of thin branches or stalks of cereals is placed at the bottom of the pit to allow circulation of air, which is necessary for good composting.

3. The pit is built up with waste materials, for example:

- weeds
- stalks (well chopped)/ leaves from harvested plants
- kitchen waste
- household sweepings

4. Some old, well rotted compost and manure should be added to help the composting process to get going.

5. The pit must be kept moist by watering, and must be turned occasionally.

6. When the compost is well rotted (black and crumbly) it is ready for use – in *zai* for example. One pit makes enough for a handful or two of compost in the *zai* of 2-3 hectares.

7. Usually each pit is filled and emptied for use once each year.

## 2. PATECORE

### HOW PERMEABLE ROCK DAMS ARE BUILT

1. The site for the permeable rock dam is identified by the village committee.
2. The most suitable sites are where gullies are beginning to form in the middle of productive land.
3. Where possible a series of permeable rock dams should begin at the top of a valley.
4. Sites immediately above gully heads should be avoided – because the permeable rock dams may be undercut.
5. If the gully which the dam crosses is less than one metre deep, no spillway is required.
6. Where a spillway is needed – to allow passage of heavy flows – it can be made from gabion baskets (wire cages filled with stone), where available.
7. Using a water tube level, the alignment of the main “wings” of the dam is marked out. The wings approximately follow the contour, and therefore they curve back down the valley.
8. A shallow foundation is dug in places where the

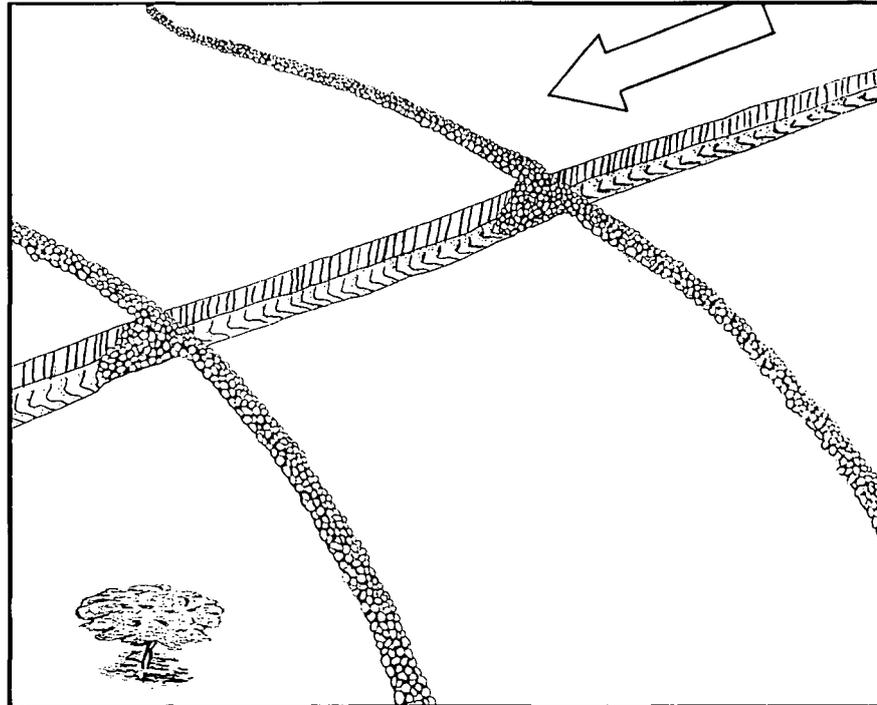


FIG 5: PERMEABLE ROCK DAMS

lessen the damage if an early flood occurs. The top is surveyed with the water tube level to make sure it is level.

### Where Permeable Rock Dams can be used:

- Suitable in dry areas with less than 700mm rainfall
- Where gullies are forming in productive land
- Slopes should be less than 2%
- Good supply of stone and transport are essential

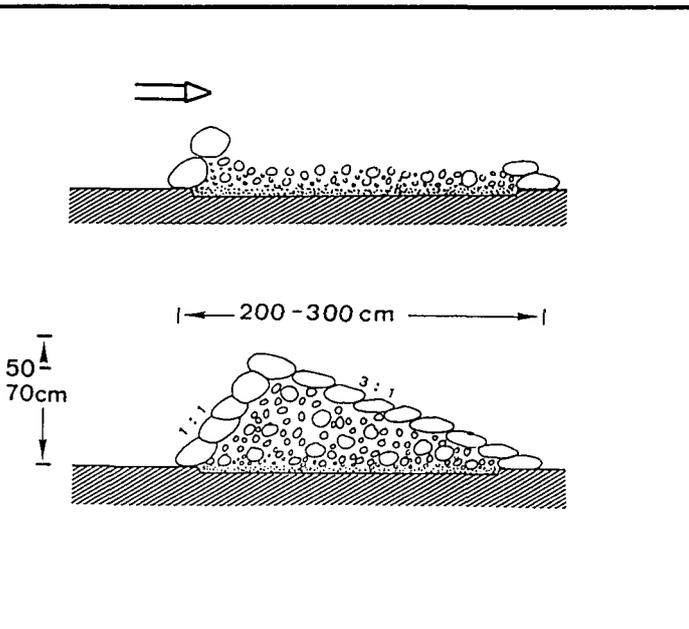


FIG 6: CONSTRUCTION OF PERMEABLE DAM

soils are easily eroded. The trench is filled with small stones/ gravel. The main dam wall is constructed carefully, using large flat stones as the casing, with smaller stones packed inside.

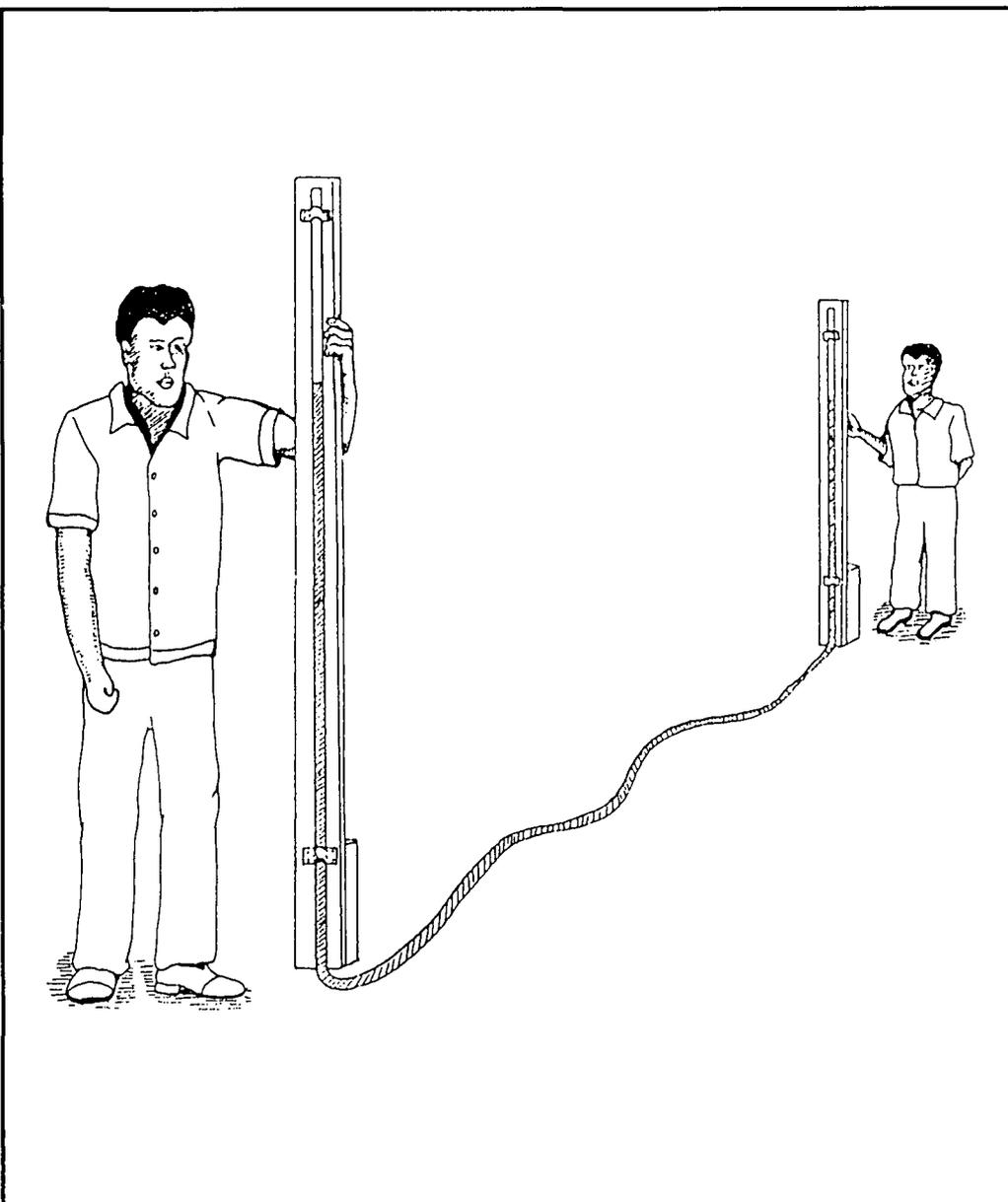
9. The wall is constructed evenly along its length to

### Measurements:

**Spacing:** 50-200m apart (ideally the top of one should be level with the bottom of the one upslope but in practice, this is not usually possible)  
**Dam wall:** 50-70cm high, 200-300cm base width  
**Side slopes:** 3:1 downslope / 1:1 upslope

### Labour/ Transport:

**Stone required** (for a dam 600m long): 300-600 cubic metres (depending on height)  
**Transport of stones by lorry:** 25-40 cubic metres per day (= 50-75 tonnes)  
**Labour for construction:** approx one person/ half cubic metre stone/ day  
**Labour for collection of stone and filling lorry:** approx one person/half cubic metre stone/ day



**FIG 7: USE OF WATER TUBE LEVEL**

## Laying out a Contour with the Water Tube Level

1. The team begins at the top of the field, and continues downslope. Two operators are necessary to hold the poles, and a third is required to trace the line on the ground with a hoe.
2. One operator ("A") remains stationary holding one pole, while the other, ("B") moves up and down the slope with the other pole until the level of water in each tube matches the "level" mark. The two points are now on the contour.
3. The person with the hoe marks the ground between the poles.
4. Operator "A" now picks up his/her pole and moves to the other side of "B" who remains stationary. It is now "A"s turn to find the correct spot.

## USE OF THE WATER TUBE LEVEL FOR SURVEYING

- The water tube level is a simple surveying instrument which is used for laying out contours in fields. It is easy to understand, and farmers can quickly learn how to operate it for themselves.
- It consists of:
  - 10-20m of clear plastic piping, with inside diameter 6-10mm
  - two poles of 1.5 -2.0 metres length
  - four rubber straps (from inner tube) to attach pipe to poles
  - one to two litres of water
- The water tube level is assembled by uncoiling the tube and then filling it with water by siphoning (sucking one end of the tube with the other end dipped in water). Each end of the tube is then tied to one pole.
- The poles are held side by side and the levels of water marked on the poles.

5. This procedure is carried on until the end of the field is reached. The distance to the next contour line is paced out, and surveying continues.
6. The true contour can now be "smoothed" by eye to make ploughing easier.

### Important Points to Remember:

- work while it is cool – heat causes the tubes to stretch
- mark the levels again if the water spills
- make sure the poles are held vertically
- don't put the poles in hollows or on lumps in the field

# KENYA

## I. MACHAKOS DISTRICT – NSWCP

### HOW A FARM IS CONSERVED USING FANYA-JUU TERRACES

1. The farm is surveyed by a technician to see if a cutoff drain is required above the fields.
2. A cutoff drain is laid out along the contour. All the runoff from outside the farm is held and infiltrates.
3. The soil dug out from the cutoff drain is heaped downslope.
4. Contours are then surveyed with a line level.
5. Soil is loosened with hoes or mattocks along the line of the contour and then thrown upslope to make the bund. A small step is left between the

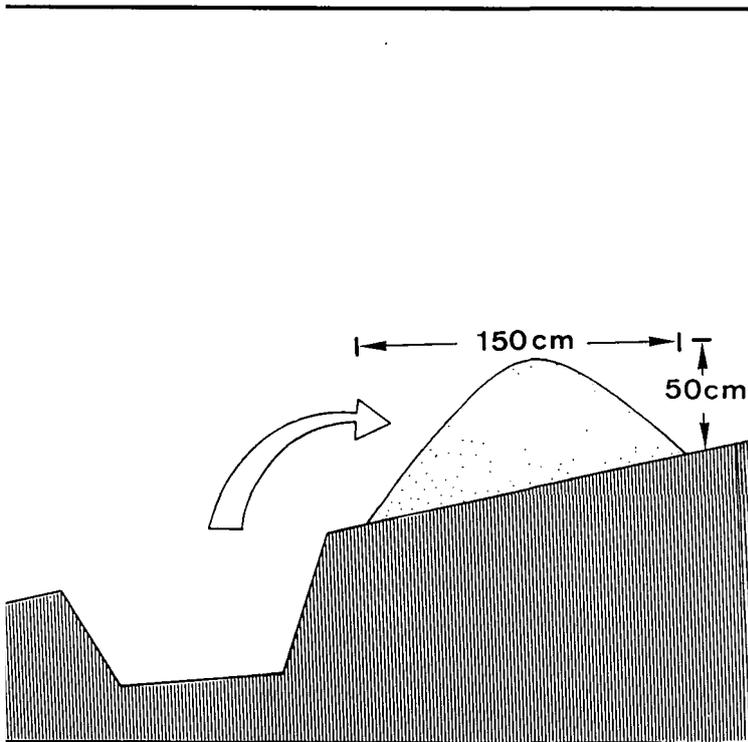


FIG 8: CONSTRUCTION OF FANYA-JUU TERRACE

trench and the bund so that soil is not washed straight back in when it rains.

6. Grass is planted on top of the bund to stabilise it. "Bana grass" is one of the best varieties for Kenya. Bananas or other trees may be planted in the trench.

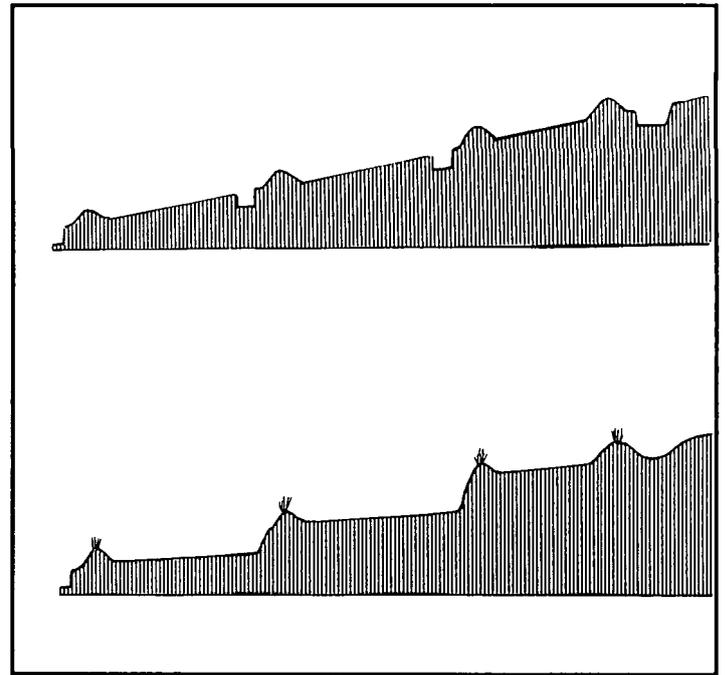


FIG 9: DEVELOPMENT OF FANYA-JUU TERRACES

7. Ploughing, weeding and natural soil movement cause the land between the terrace banks to level off into benches after a few years.

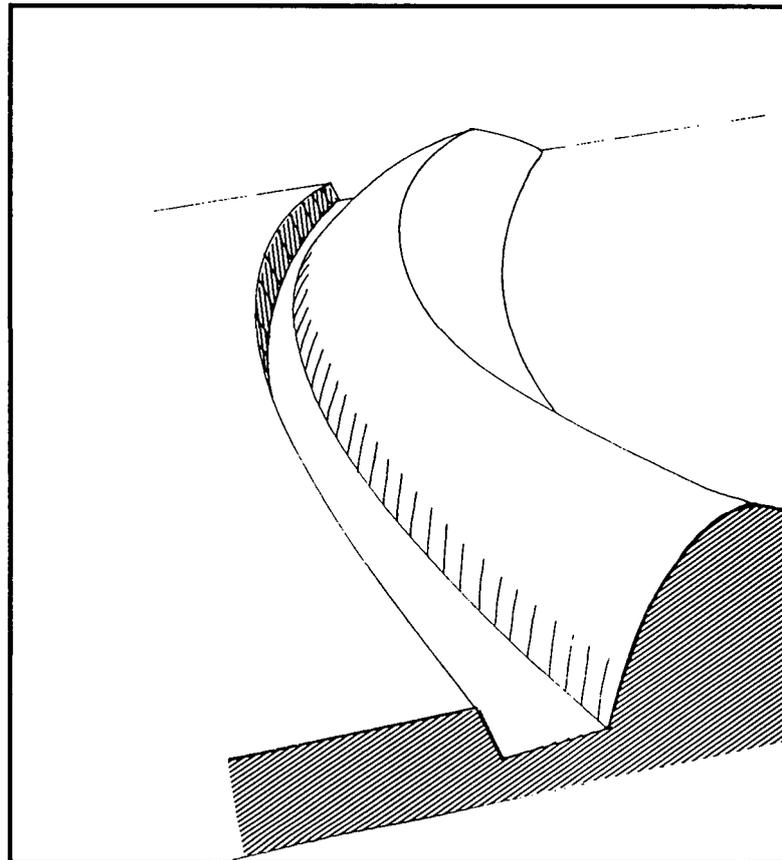


FIG 10: FANYA-JUU TERRACES

## Where fanya-juu terraces can be used

- in marginal/ wetter zones (700mm rainfall and above)
- soils should be deep
- suitable for slopes from less than 5% to 50%

### Measurements

#### CUTOFF DRAIN:

**Ditch:** 1.25 m wide at top and 1.0 metre wide at bottom

**Depth:** approx. 1.0 metre

**Gradient:** usually sited on contour, but sometimes sited on a slight gradient when it is joined to a natural waterway

#### FANYA-JUU TERRACE

##### Spacing of terrace banks:

usually between 5 and 20 metres apart, (depends on the slope of the land – the steeper the land, the closer the terrace banks)

**Trench:** 60cm wide and 60cm deep

**Bund:** 50cm high and 150cm wide at base

**Step:** 20cm between trench and bund

**Gradient:** sited on contour (in dry areas)

**Labour:** 150-350 person-days/ hectare (for cutoff and terraces)

## OTHER CONSERVATION TECHNIQUES USED IN MACHAKOS

### Conservation Farming

“Conservation farming” means reducing erosion by good crop husbandry. This includes:

- contour ploughing
- correct spacing
- strip cropping (alternating strips of different crops)
- use of farm yard manure and fertilisers.

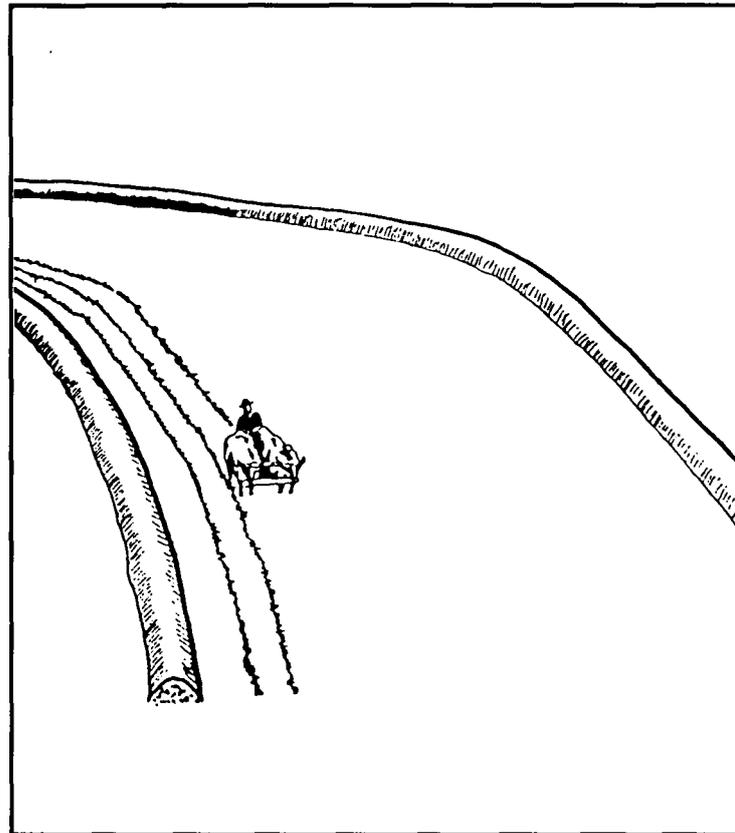


FIG 11: CONTOUR PLOUGHING

### Grass Strips

Grass strips are a cheap alternative to fanya-juu terracing. A grass like “Makarikari” (*Panicum coloratum*) is planted in dense strips, up to a metre wide, along the contour. The grass slows down runoff and silt builds up in front of the strip. Benches are formed, though this takes a long time to occur.

### Gully Control

Gully control is expensive and therefore not usually a priority, except where gullies threaten good land, roads or buildings. Gullies are stabilised by the use of a variety of materials, including brushwood held in place by stakes of wood from trees which sprout from cuttings (eg *Commiphora* spp.).

## 2. LOKITAUNG PASTORAL DEVELOPMENT PROJECT

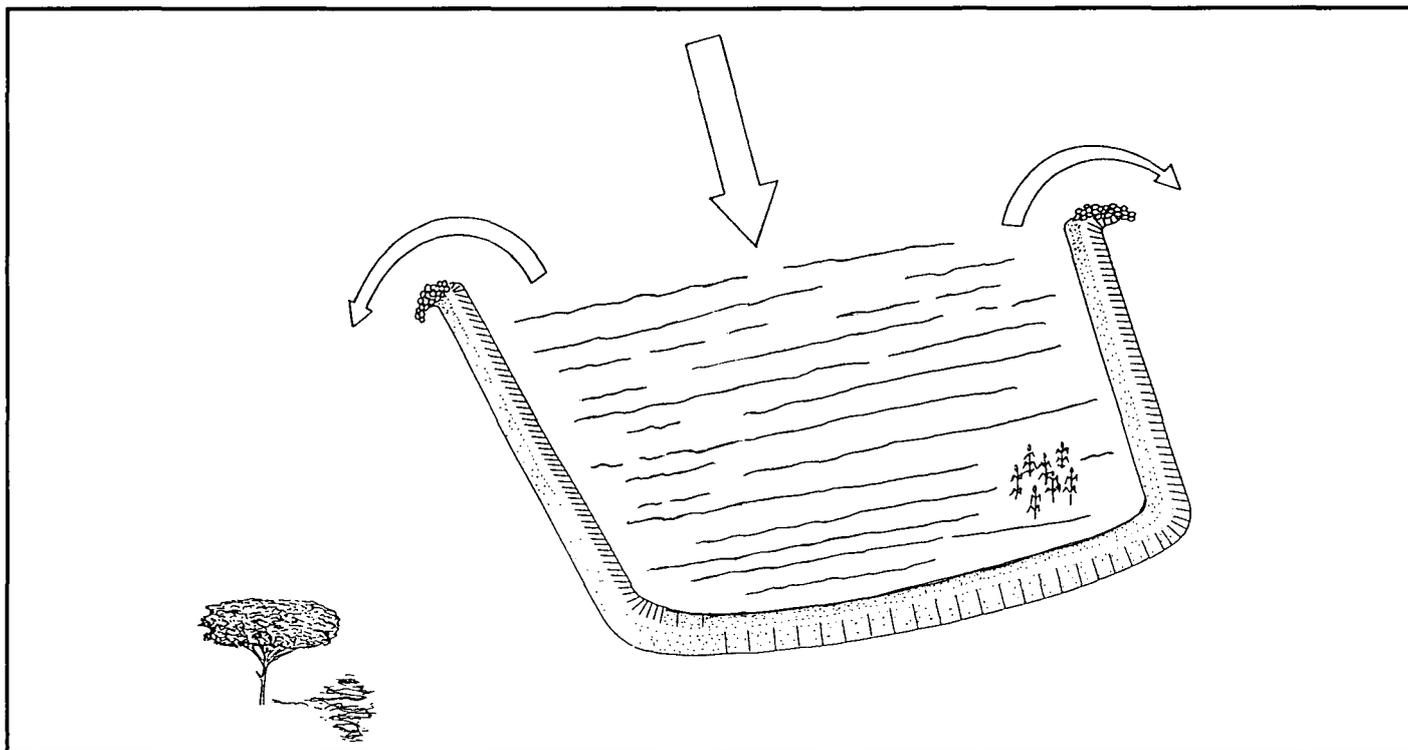


FIG 12: RAINWATER HARVESTING GARDEN

### HOW A RAINWATER HARVESTING GARDEN IS MADE

1. A suitable site for the garden is chosen – this is where a small gully brings rainwater runoff to the plot.
2. Starting from the centre of the plot, a line level is used to survey the land before levelling (see next section).
3. The position of the “bottom” bund and the side bunds are pegged out after discussions between plot owner and technician.
4. The outline of the bund’s cross section is marked with stakes and string to guide construction.
5. Oxen scoops are used to level the plot and to collect soil for construction.
6. Soil is carried in basins, and layer by layer the bunds are compacted by foot.
7. The line level is again used to make sure the top of the bund is level around the whole plot, and that the tips of the side bunds are on the same contour.

8. The tips of the side bunds are then protected from erosion by covering with loose stone.
9. Where too much runoff from the catchment is a problem, a diversion ditch is made to prevent runoff entering the field.

### Where a Rainwater Harvesting Garden can be used:

- only suitable for the driest areas (less than 400mm rainfall)
- deep soils necessary
- soil should not be a “cracking clay”
- slopes less than 2%

#### Measurements

**Plot size:** 0.5 – 2.0 hectares  
**Earth moved:** 500-1000 cubic metres per hectare  
**Maximum depth of flooding (before overflow around the spillway occurs):** 25cm  
**Maximum dimensions of the bund:**  
 height – 1 metre  
 base width – 8 metres  
 top width – one metre  
 sideslopes – (3 or) 4:1 downslope/ 3:1 upslope  
**Labour required:** 250-500 person-days/ hectare (when oxen scoop used)

## USE OF THE LINE LEVEL FOR SURVEYING

- The line level is a simple instrument which is used for laying out contours and for other simple surveying tasks. It is quick to operate, accurate and easy to transport.
- A line level consists of two poles which may be short (as in Turkana) or the height of a person (as in Machakos). A notch is made in each pole at exactly the same height and one end of a length of string (usually 8 metres) is tied to each notch.
- The centre of the string is marked and a builder's spirit level is hung on the string at this point.
- When the bubble is in the middle of the spirit level, the two poles are on ground of equal elevation – that is, the two points are “level” or “on the contour”.

### How to Lay Out a Contour

1. Each pole is held by an operator and the line level read by a third person. The first pole is held by operator “A” who remains stationary. Operator “B” then moves up and down the slope until the level reads dead centre.
2. The two positions are marked, and while “A” moves to “B’s” old position, “B” moves onwards

and the process continues until the length of contour required has been completed.

3. The true contour is then “smoothed” by eye to give a better shape for ploughing.

### How to Survey Land for Levelling

1. The centre of the field is used as the starting point. A flat stone is placed in a hole with one side level with the ground surface. This is the “bench mark”.
2. Operator “A” places his/her pole on this stone. “B” stands downslope with his/her pole on top of a wooden peg. The peg is driven into the ground until a level is found. The top of the peg will be above ground surface. “A” then moves the pole to this peg, and “B” continues down the field and places his/her pole on another peg.
3. The process is similar for the upslope part of the field, except that the pegs are driven below ground to find the level.
4. During the land levelling process, soil is scraped away from around the upslope pegs, and deposited around the downslope pegs. This continues until the tops of all the pegs are at the new surface level.

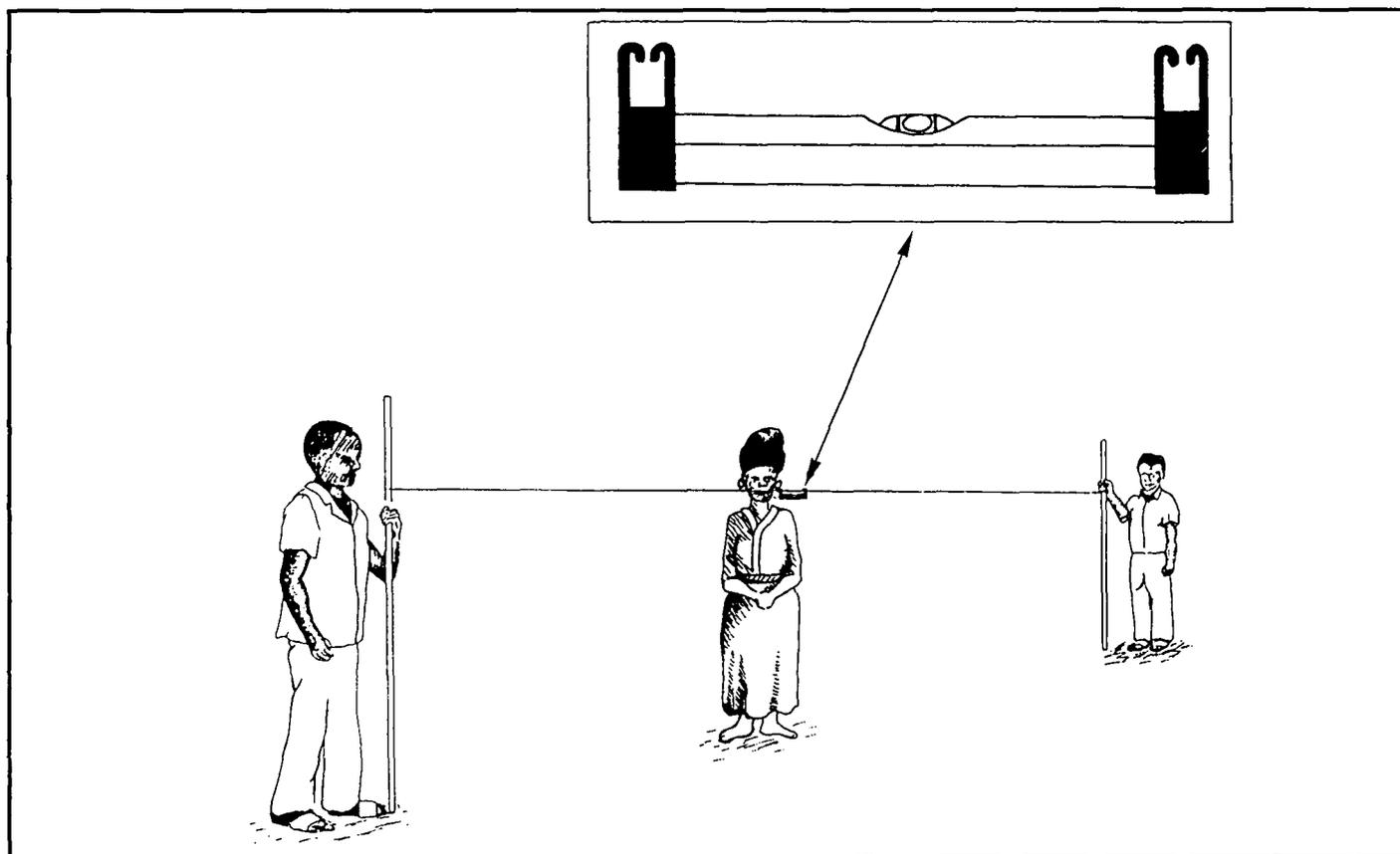


FIG 13: USE OF LINE LEVEL

# MALI

## I. TRADITIONAL TECHNIQUES ON THE DOGON PLATEAU

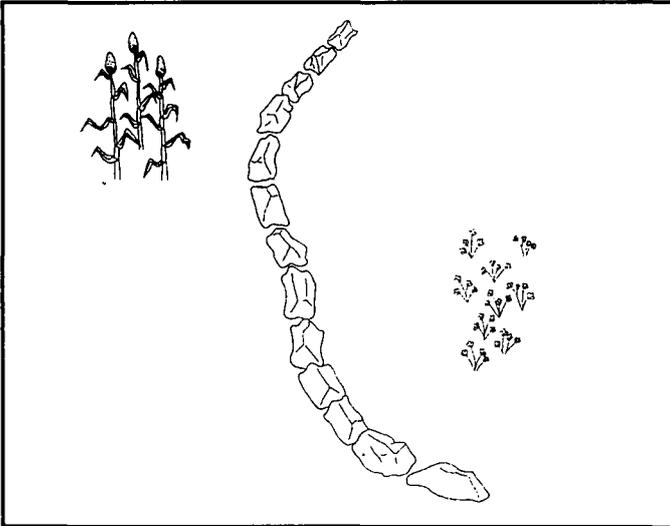


FIG 14: STONE LINES

### I. STONE LINES

#### How They Work

- The idea of stone lines is to slow runoff and reduce erosion.

#### Location and Construction

- Stone lines are used very widely, on cultivated land – and also barren land which is to be used in future – where the slopes are shallow and where stones are available.
- Stone lines are placed approximately across the slope. Distance between the lines depends on availability of stones.

#### Measurements and Labour

- The structures often consist of just a single line of large stones, of 20-30 cm height.
- No estimates of labour requirements are available.

#### Improvements Possible

- Possible improvements include placing the lines on the contour, and building them slightly higher, and more carefully to avoid runoff forming small rills between them. A small foundation trench would also improve their effectiveness.

## 2. EARTH MOUNDS

### How They Work

- The small mounds dug between plants help to slow runoff as well as acting as “mini-compost heaps”, improving soil fertility.

### Location and Construction

- Earth mounds are used throughout the Dogon Plateau, and also elsewhere in the drier parts of Mali.
- Mounds are constructed during the first weeding in July when weeds are scraped together and covered with earth.
- The next season’s seeds are planted into what remains of the mounds – where the fertility of the soil has been improved.

#### Measurements and Labour

- The mounds are about 20 cm high, and are spaced between clumps of plants – often about a metre apart.
- It is estimated that it takes about 10-15 person/days to form mounds on an hectare of cropped land.

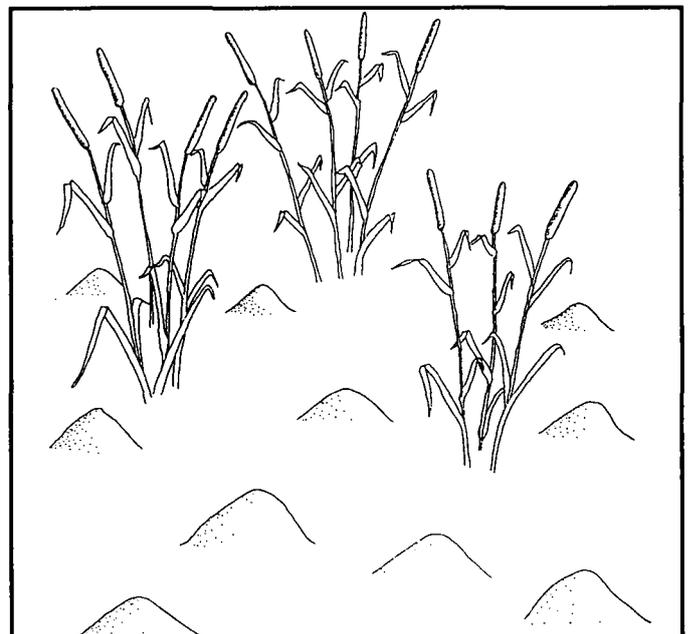


FIG 15: EARTH MOUNDS

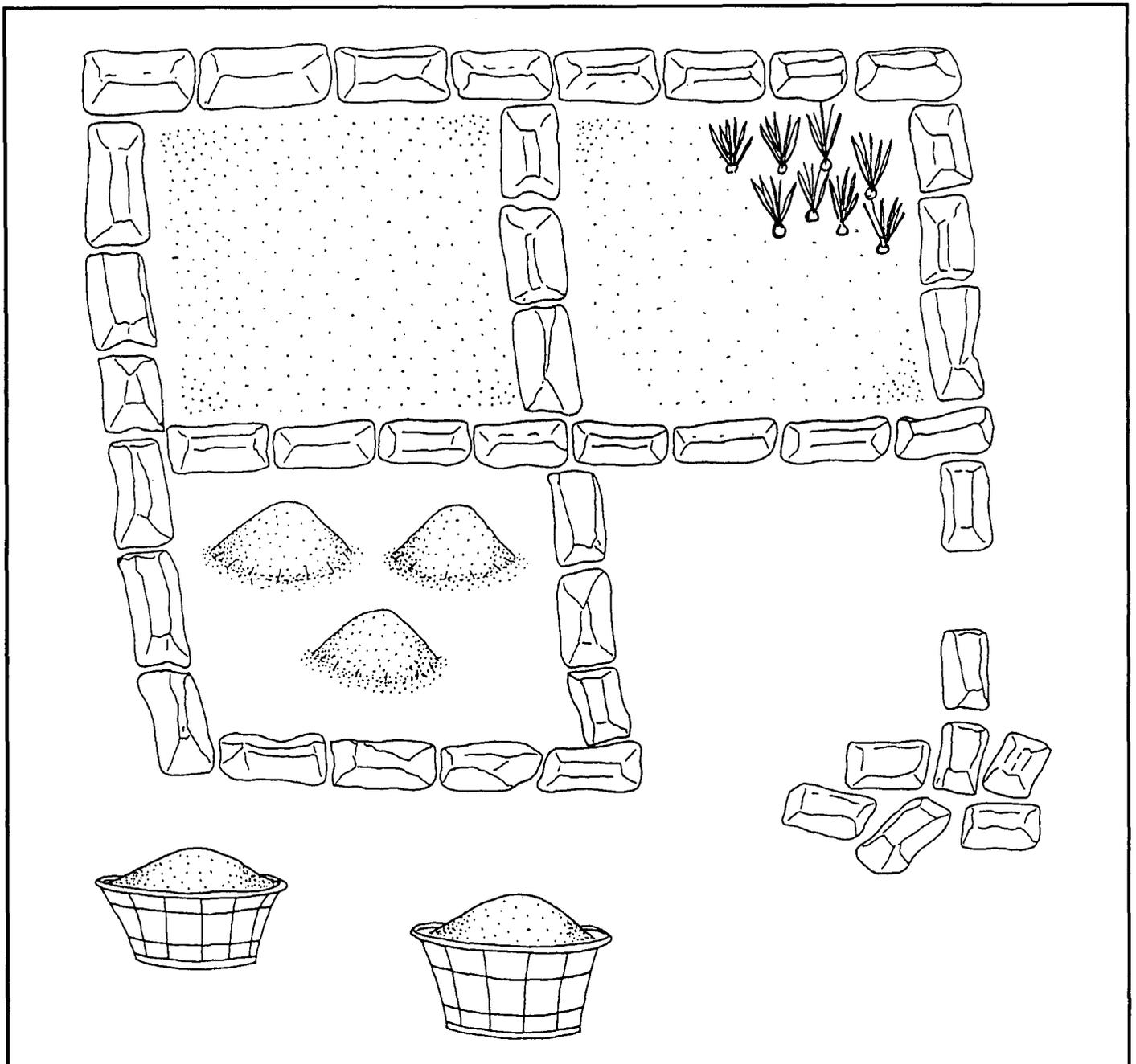


FIG 16: ONION GARDENS MADE FROM TRANSPORTED EARTH

### 3. ONION GARDENS made from Transported Earth

#### What They Are And How They Work

- Artificial onion terraces are made by the sides of watercourses where water is available, but there is no soil.
- A network of small stone squares is built on the bare rock and after being filled with earth is planted with onions or another vegetable crop.

#### Construction

- The stone is brought from nearby quarries if it is not available locally.
- These squares or “terraces” are then filled with

earth collected from the riverbanks and carried in baskets.

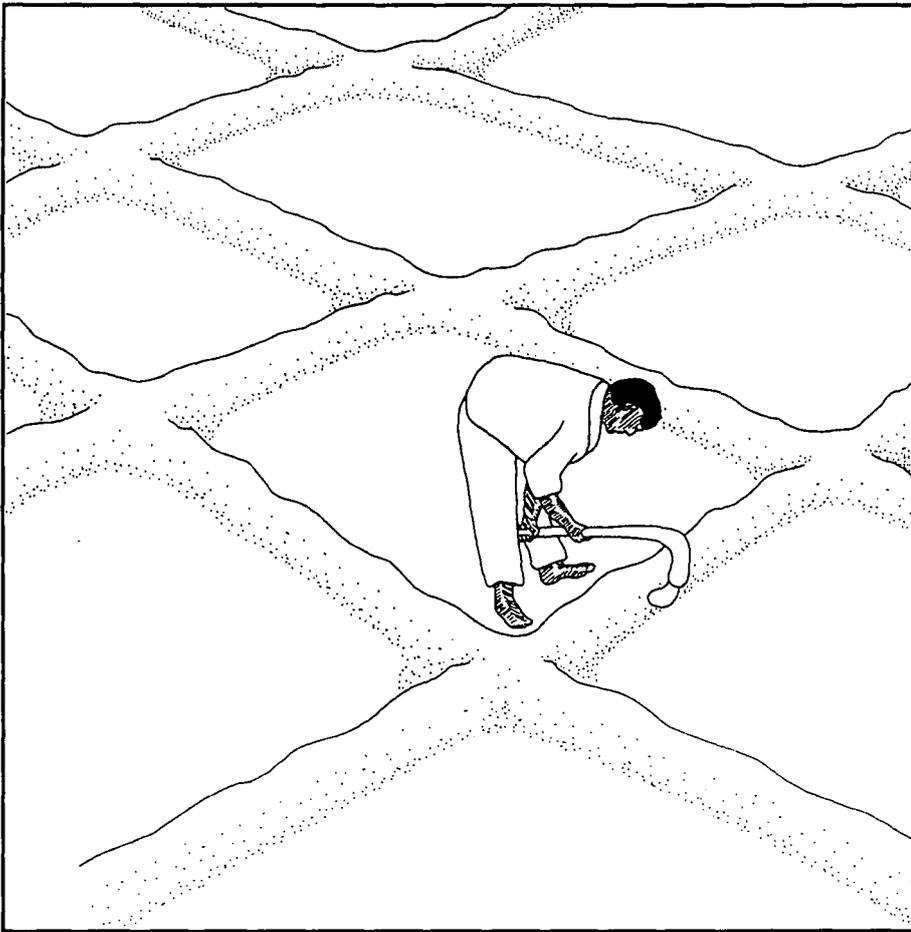
- Manure is added to the earth to make it more fertile.

#### Planting

- Onions or other vegetables are planted in the gardens and irrigated by hand from the nearby water source.

#### Measurements and Labour

- The squares have sides of about 1 – 1.5 metres, and the soil depth is initially at least 15-20cm.
- It takes a very great deal of labour to make these gardens. One estimate is between 500 and 1,000 person/ days per hectare but it may be even more if soil and rock are not available close to the water source.



**FIG 17: EARTH BASINS**

## **4. EARTH BASINS**

### **How They Work**

- The small earth basins are intended to hold all of the rainwater which falls, therefore giving complete conservation of water and soil within the field.

### **Location and Construction**

- Earth basins are made in agricultural fields where the soils are relatively deep.
- Construction of the basins takes place during the dry season, and they are built up later when crops are weeded.

### **Measurements and Labour**

- Basins are made in the form of squares with each side measuring between one metre and two metres in length. The basins are largest on flatter land and smallest on more sloping land.
- Each basin is surrounded by a small earth ridge, made by a hoe, of about 15cm in height.
- This technique takes quite a large amount of work, but no accurate estimates of labour requirements are available.

## 2. PROJET LUTTE ANTI-EROSIVE

### HOW CONSERVATION MEASURES ARE PLANNED FOR DIFFERENT LAND USE CATEGORIES

1. At the start, a cross-section or "profile" of a typical catchment in the Koutiala area was used (see fig 14) to help plan for solutions to the overall conservation problem.
2. The different land categories – plateaux, escarpments, gentle slopes etc – were then studied. From these categories, three main land use zones were identified. These zones, together with their particular problems and the technical solutions proposed are as follows:

#### The Cultivated Zone (a)

**Location:** on the gentle slopes where there are deep soils

**Problems:** runoff from the plateaux and escarpments causing sheet and rill erosion in agricultural fields

**Conservation Techniques Recommended:**  
- contour stone bunds just above the fields to slow runoff from the land above

- live fences around the fields
- grass strips within the fields
- check dams made from stone or cereal stems in rills and gullies
- use of manure from the improved cattle pens in the fields – improved crop husbandry, such as tied ridging

#### The Protection Zone (b)

**Location:** the escarpments and the banks of the streams

**Problems:** severe erosion and deforestation

**Conservation Techniques Recommended:**  
- protection from grazing  
- revegetation with trees and grass

#### The Silvo-Pastoral Zone (c)

**Location:** the plateaux and other areas not used for cropping

**Problems:** lack of vegetative cover

**Conservation Techniques Recommended:**  
- control of bush fires  
- control of grazing  
- control of tree cutting for fuelwood  
- use of improved cooking stoves (an indirect measure)

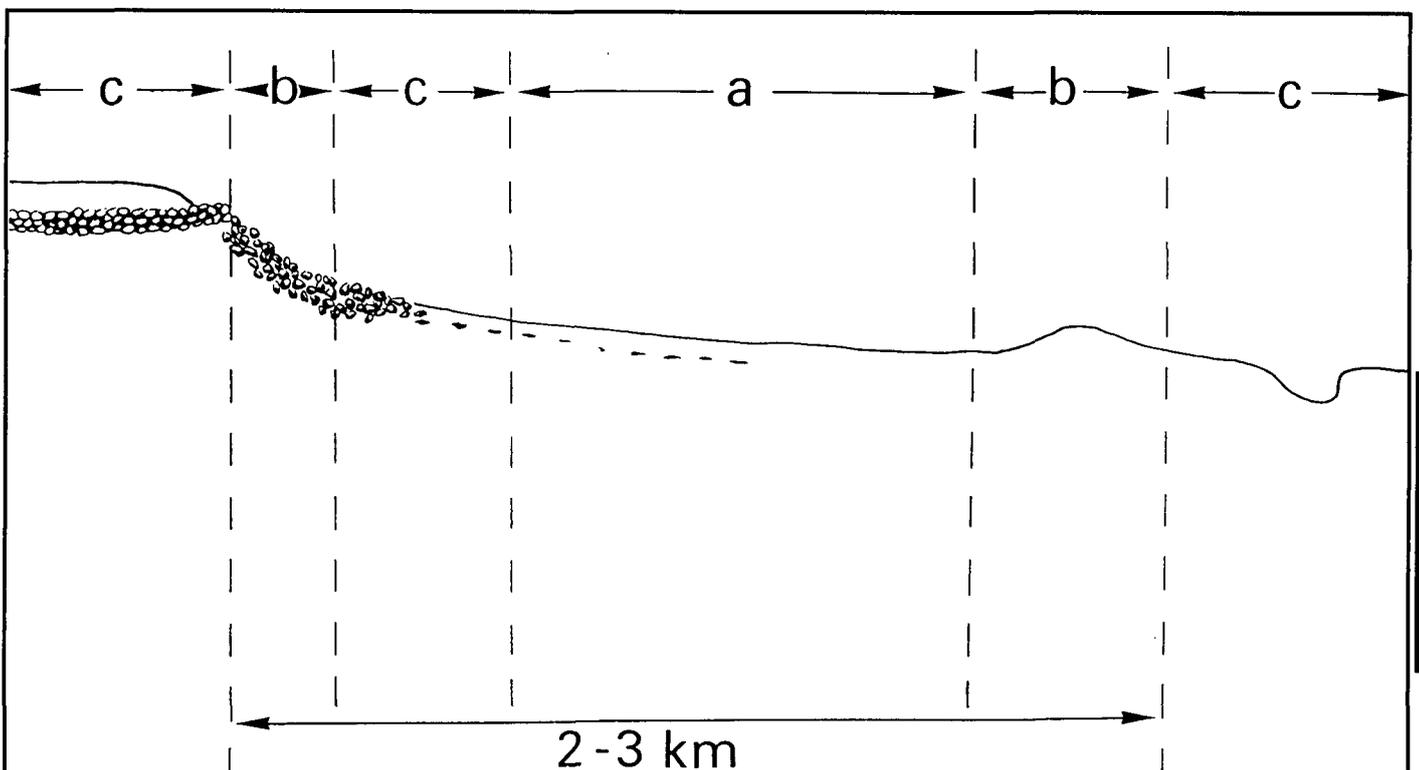


FIG 18: PROFILE OF TYPICAL CATCHMENT (ZONES a, b & c DESCRIBED ABOVE)

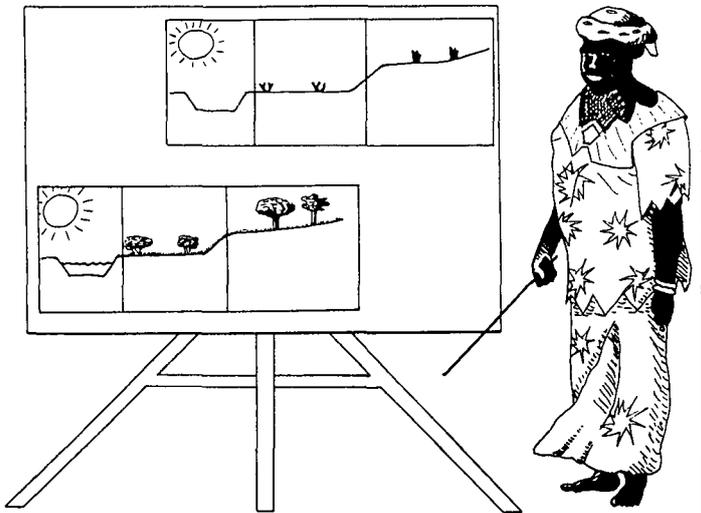


FIG 19: A FLANNELGRAPH - PART OF THE "GRAAP" METHOD

3. Villagers are involved in land-use planning by means of the "GRAAP" method of interactive training. This includes the use of "flannelgraphs" where images are stuck on a felt screen.

## GRASS STRIPS

### How They Work

- Grass strips are a vegetative method of erosion control.

- The strips run in a straight line across the slope, within cultivated fields.
- Runoff is slowed by the strips and silt deposited.
- Technically grass strips work well, but there have been some problems including shortage of appropriate seed, and the growth of weeds within the strips.

### Planting

- The grass species planted are selected for their value as fodder as well as ground cover.
- Brachiaria ruzizensis has grown well, but Pennisetum pedicellatum proved less good for ground cover or for fodder.

### Where Grass Strips are Suitable

- Grass strips such as these are most suitable for the areas with above 700mm annual rainfall, as in southern Mali.

#### Measurements and Labour

- The original design was for strips 5 metres wide and 50 metres apart, but farmers objected to the loss of land, so strips were reduced to 3 metres wide and spaced up to 100 metres apart.
- One person can plant about 10 metres of a grass strip in an hour (including ploughing).

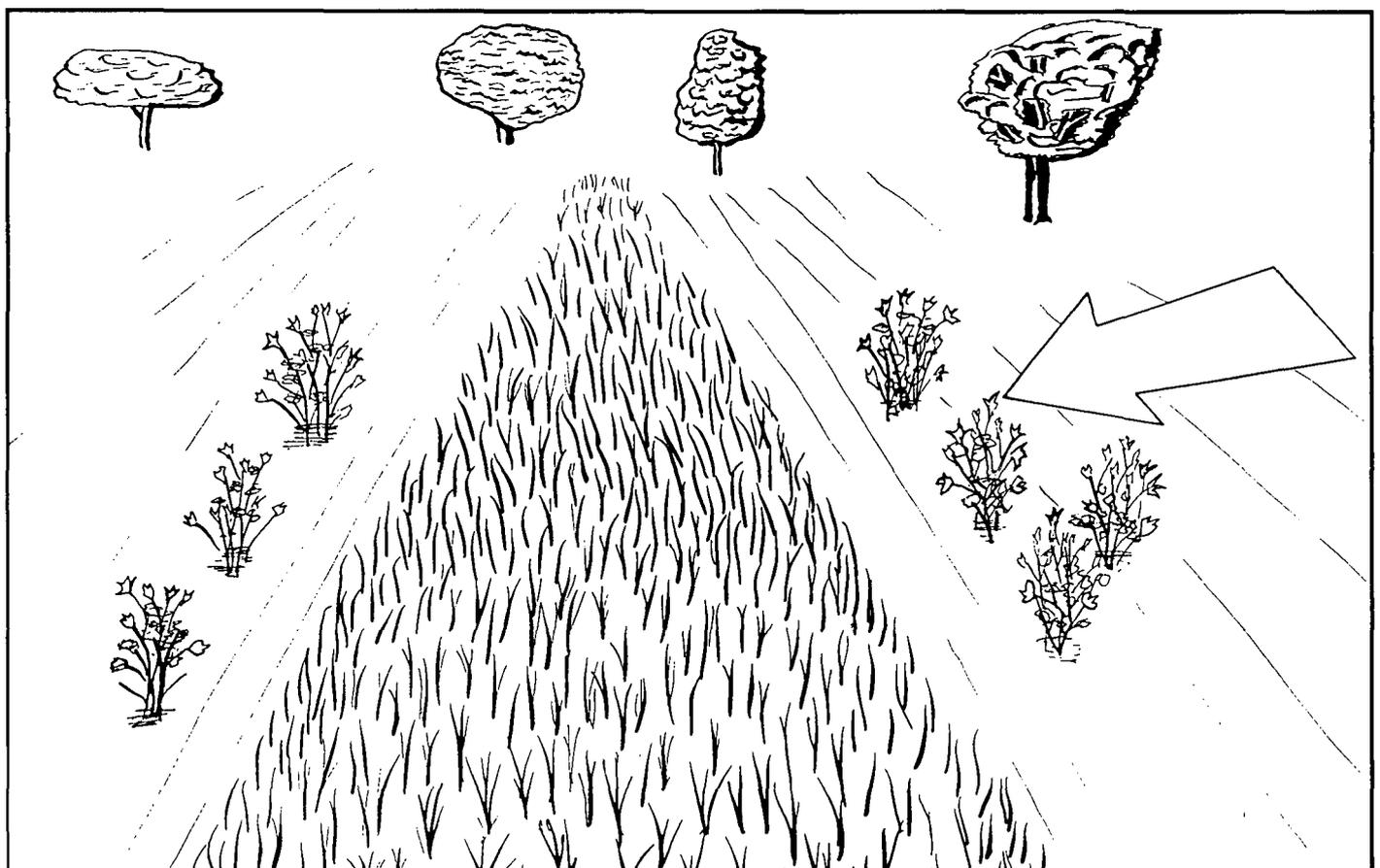


FIG 20: GRASS STRIPS

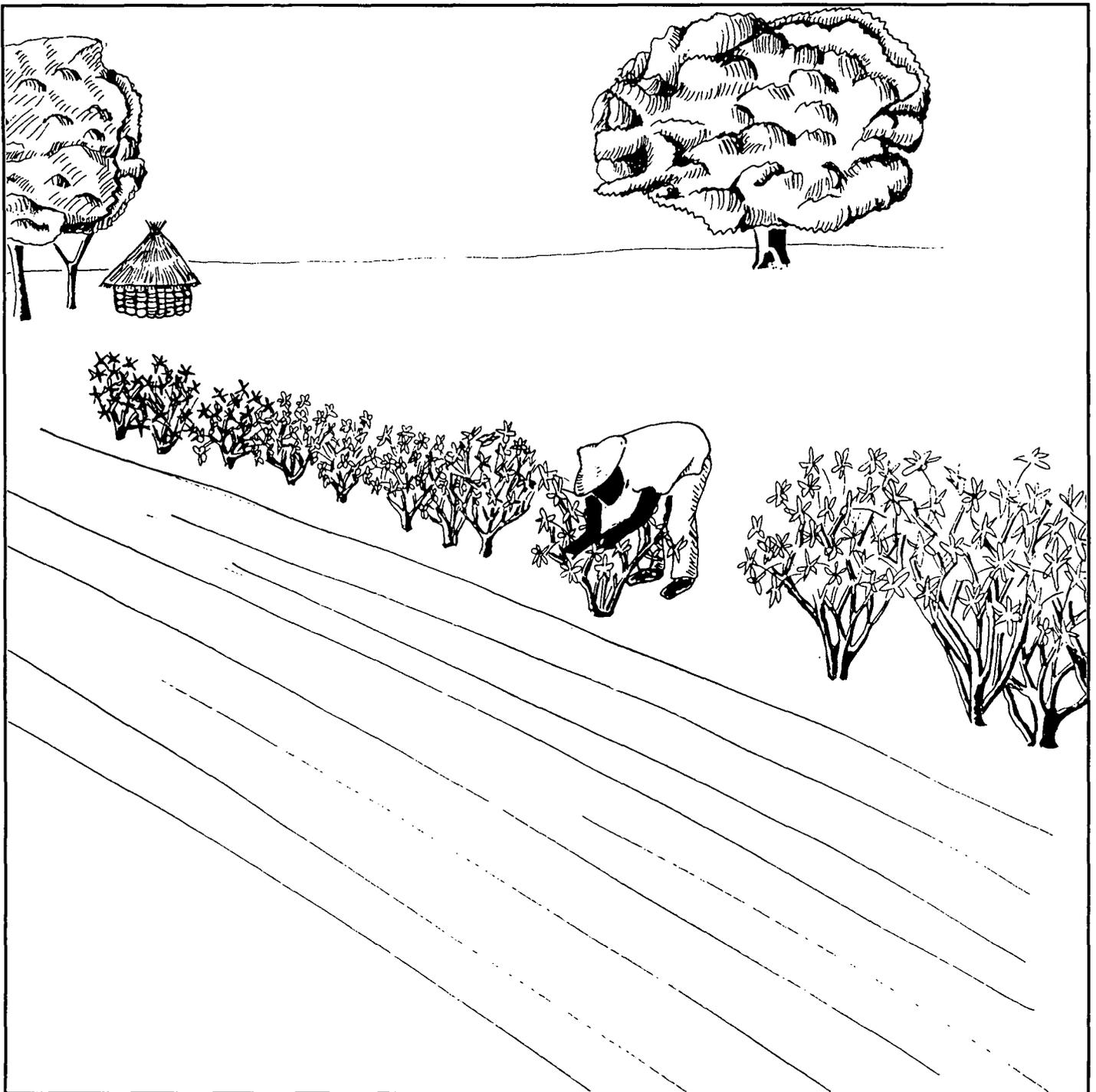


FIG 21: LIVE FENCES

## LIVE FENCES

### How They Work

- Live fences are planted for two reasons:
  - to protect fields from animals
  - to act as a vegetative barrier to runoff

### Planting

- Cuttings of *Euphorbia balsimifera* are planted closely together to form hedges around agricultural fields.
- Other species tested have been *Balanites sp.*, *Cajanus cajun.* *Ziziphus sp.* and *Acacia spp.*

- Planting takes place before the rainy season. This is because *Euphorbia* cuttings prefer to be planted dry. This is an advantage because labour is available at this time.
- Hedges are planted around each farmer's land and also around individual fields within it.

### Where Live Fences are Suitable

- Live fences of different *Euphorbia* species can be used very widely in the drylands of sub-Saharan Africa.

#### Labour

- One person can plant about 20 metres per hour (of *Euphorbia*).